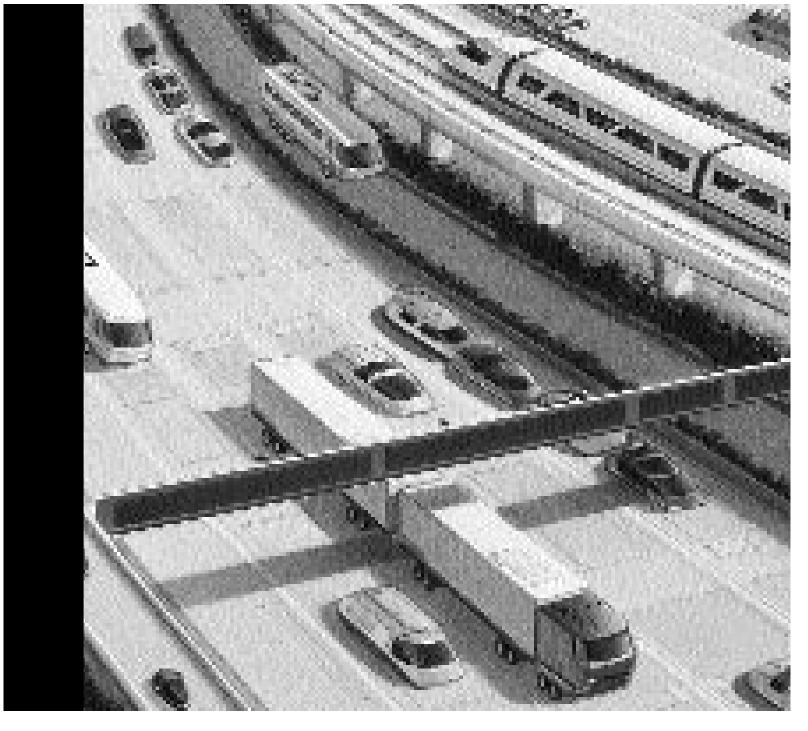
THE FIVE-YEAR PROGRAM



California's ATS Program is comprised of six major program areas. Within these program areas a significant level of activity is underway. The areas are:

- **Transportation Information Services**
- **Advanced Vehicles**
- **Transportation Management Systems**
- **Rural**
- **Infrastructure Construction and Maintenance**
- **Systems Development, Integration and Implementation**

The five-year program contains research, testing and early deployment activities described by major program area which are linked to the user services discussed earlier in the "Fifteen-year Deployment Overview." In addition, current ATS Program tests and demonstrations are summarized and some significant projects highlighted.

Activity charts are also included for each program area. The charts are located between each scope and project highlights section and depict activities necessary to accomplish deployment of a user service. **Accordingly, the charts also reflect work done by all partners necessary to accomplish the Caltrans ATS Program**.

Several of the activities described such as: traveler-based detection/call boxes, transportation management center/initiated route guidance for incident management, commercial vehicle projects, and prototype high-occupancy vehicle enforcement systems, will require the California Highway Patrol or other public and/or private entities to actively participate in the development and deployment of these systems. Caltrans will work cooperatively in partnerships with various entities to assist with these activities through deployment. The following is a discussion of each major program area and the related elements (user services or components) though 2000.

TRANSPORTATION INFORMATION SERVICES

Transportation Information Services is a package of user services which are cost-effective ways to improve mobility and provide travel substitution.

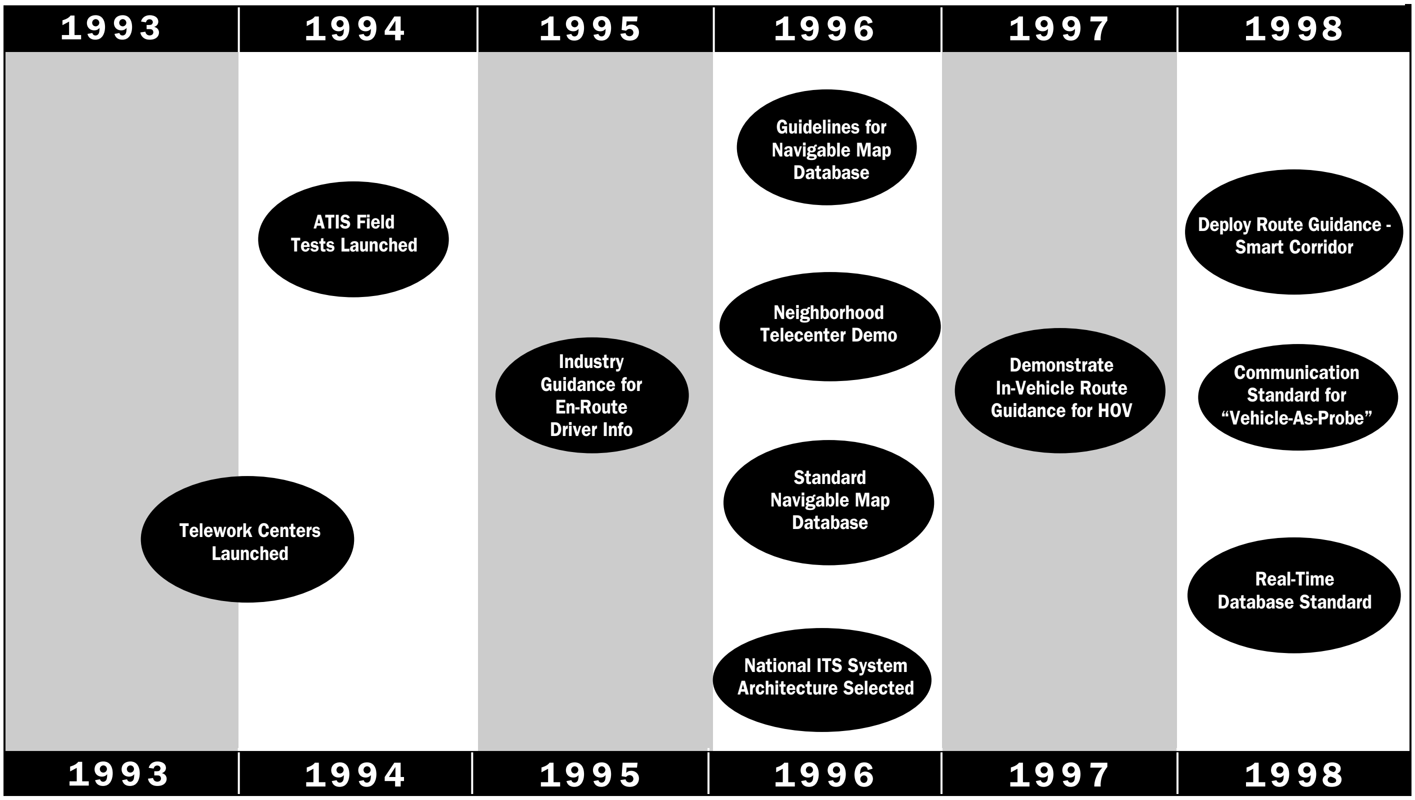
Smart Traveler/Modal Services

- *Pre-Trip Travel Information*
- *En-Route Driver Advisory*
- *En-Route Transit Advisory*
- *Traveler Services Information*
- *Route Guidance*
- *Ridematching and Reservations*

Travel Substitution

The milestones, scope of services, activities and specific project highlights for Transportation Information Services are discussed on the following pages.

Transportation Information Services



Transportation Information Services

Smart Traveler/Modal Services — Scope

The concept of the "Smart Traveler" relies heavily on the effective use of a variety of advanced communication technologies that can collect, process, and present transportation data to the traveler when and where it is needed.

Smart Traveler/Modal Services applications generally fall into these broad user services categories:

• Pre-Trip Travel Information

Provides information for selecting transportation modes, travel times, and route decisions before departure.

Pre-trip travel information allows travelers to access a complete range of intermodal transportation options at home, work, and other major sites where trips originate. For example, timely information on transit routes, schedules, transfers, fares, and ride matching services are included. Updates of real-time information on accidents, road construction, alternate routes, traffic speeds along given routes, parking conditions, event schedules, and weather information complete the service.

This capability gives a prospective traveler a quick picture of important conditions and services at a given time. Optional itineraries can be presented based on factors including time of departure, time of arrival, routes and modes, and intermediate stops. In its more advanced forms, user profiles will enable customized interfaces to better address multicultural and general variations.

• En-Route Driver Advisory

Driver advisories and in-vehicle signing for safety, convenience and efficiency.

Driver advisories are very similar to pre-trip travel information, once travel begins. Audio and visual technologies convey information about incidents, construction, congestion, parking availability, rideshare requests, and weather conditions to drivers. In-vehicle signing, the second component of en-route driver information, would provide the same types of information found on physical road signs today, directly to the vehicle. Vision-impaired individuals and drivers of rental vehicles are potential users. The service would be extended to include indications of road conditions and safe speeds for specific types of vehicles (e.g., autos, buses, vans).

• En-Route Transit Advisory

Provides information to travelers using public transportation after they begin their trips.

En-route transit information is similar to the pre-trip travel information available (noted above) to those using public transportation. Real-time, accurate transit network information helps travelers make effective transfer decisions and itinerary modifications as needed while a trip is underway. Accordingly, en-route driver information is useful to public transportation drivers, while en-route transit information focuses on transit riders.

• Traveler Services Information

"Electronic Yellow Pages" integrated with pre-trip and en-route information system.

Traveler services information provides quick access to travel related services and facilities in the vicinity of a planned trip or one already underway. These services will be accessible in the home or office to help plan trips, and with some limitations, while en-route. The location, and availability of food, lodging, parking, automotive services, hospitals, and police facilities are a few examples of pertinent information included. When fully deployed it will connect users, sponsors, and providers interactively, allowing the users to request and provide needed information. A comprehensive, integrated traveler services information system could support financial transactions like automatic billing for purchases.

• Route Guidance

Provides travelers with simple instructions on how to reach their destinations.

Route guidance closely relates to en-route driver information, potentially using the same information as its foundation. Route guidance services, however, will use information on travel conditions to provide directions. For example, a map display with areas of congestion highlighted, qualifies as en-route driver information. A route guidance service would process this data to derive a suggested route and associated instructions.

When fully deployed, route guidance systems will provide travelers with directions to selected destinations. This service can be tied to multimodal traffic management for the purpose of balancing the demand placed upon the system and for incident response.

• Ride Matching and Reservations

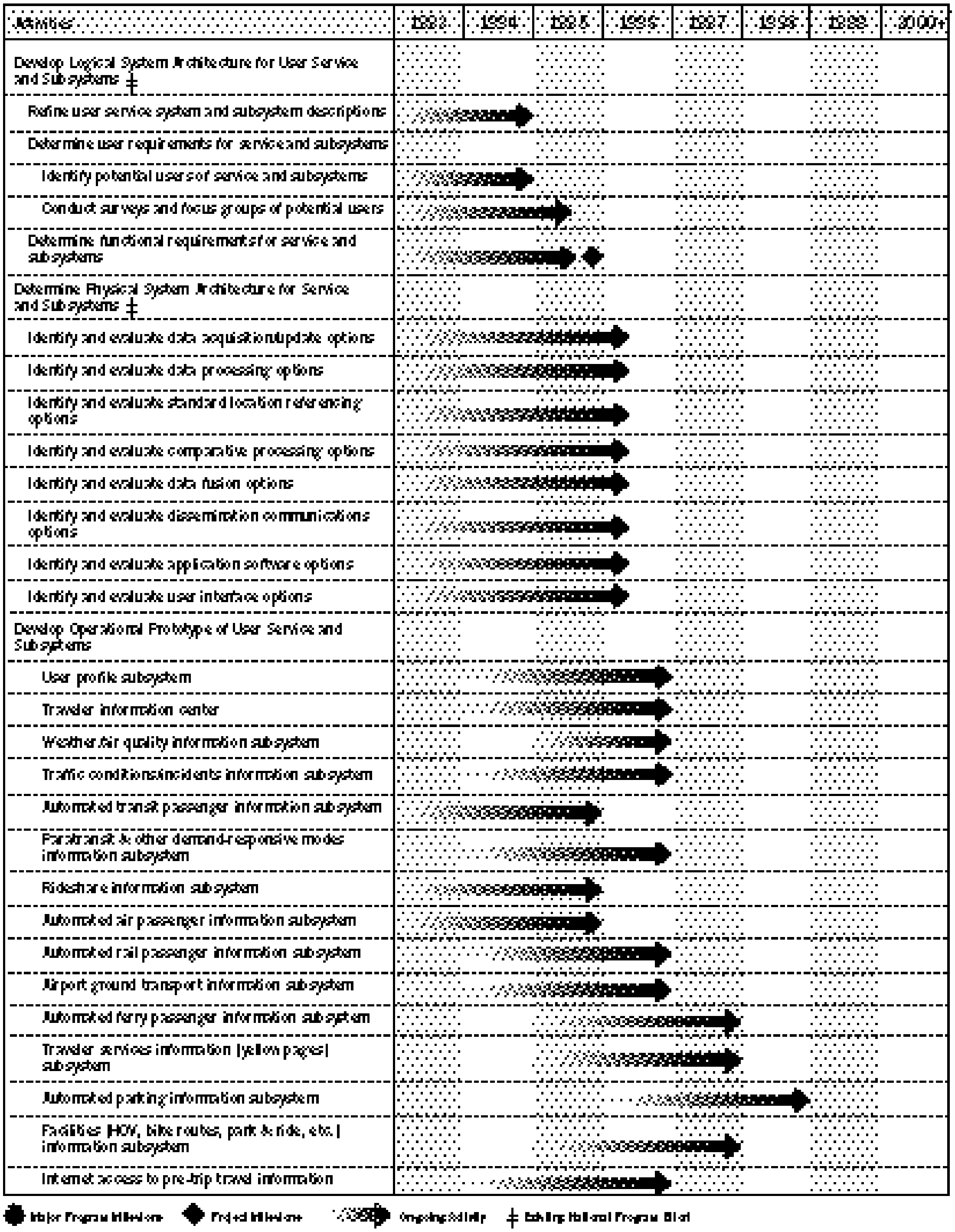
Provides for dynamic or single-trip rideshare matching.

Rideshare matching currently provides opportunities for commuters traveling between similar origins and destinations. This user service will allow for single-trip rideshare matching and en-route pickups.

Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

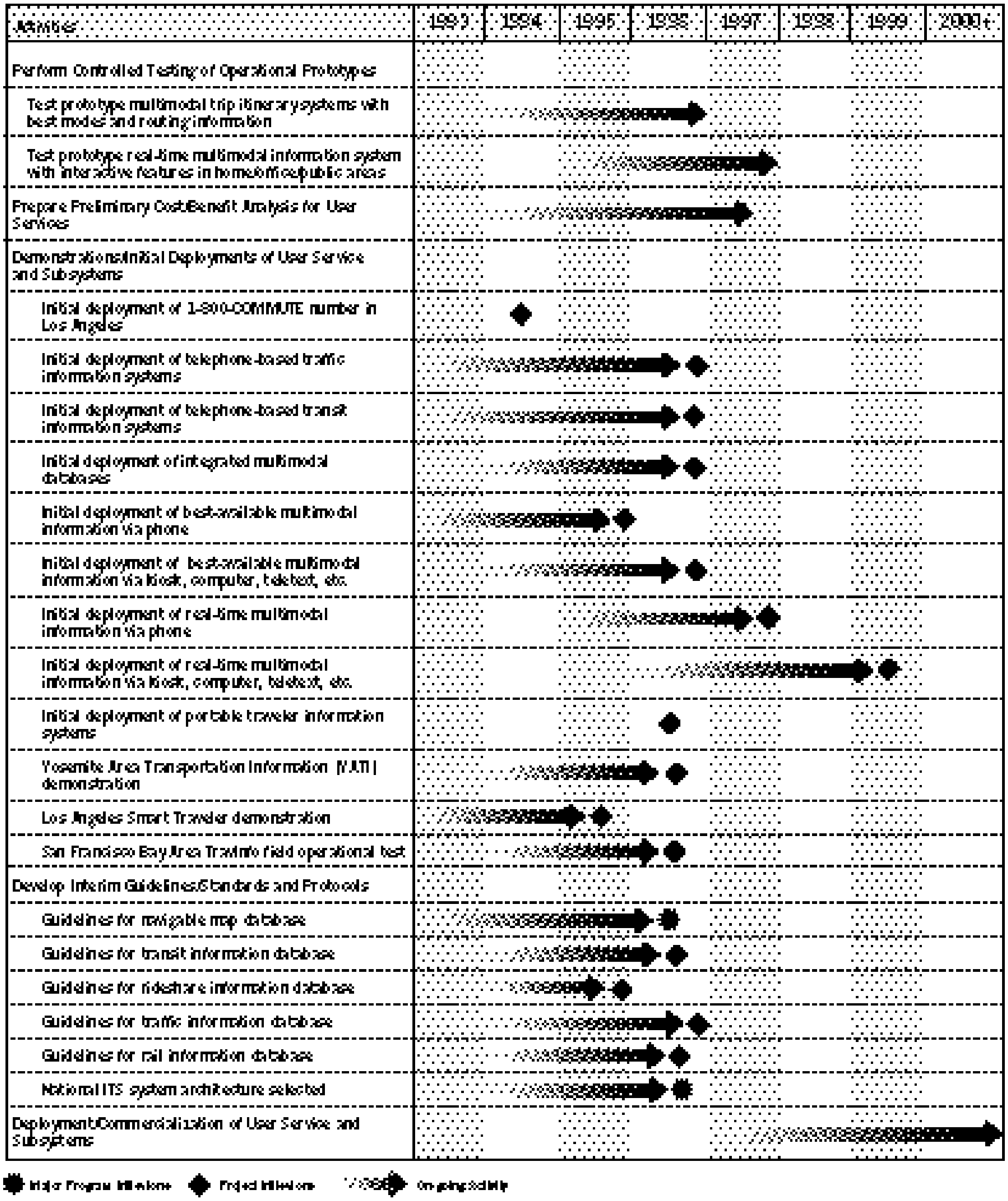
Pre-Trip Travel Information



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

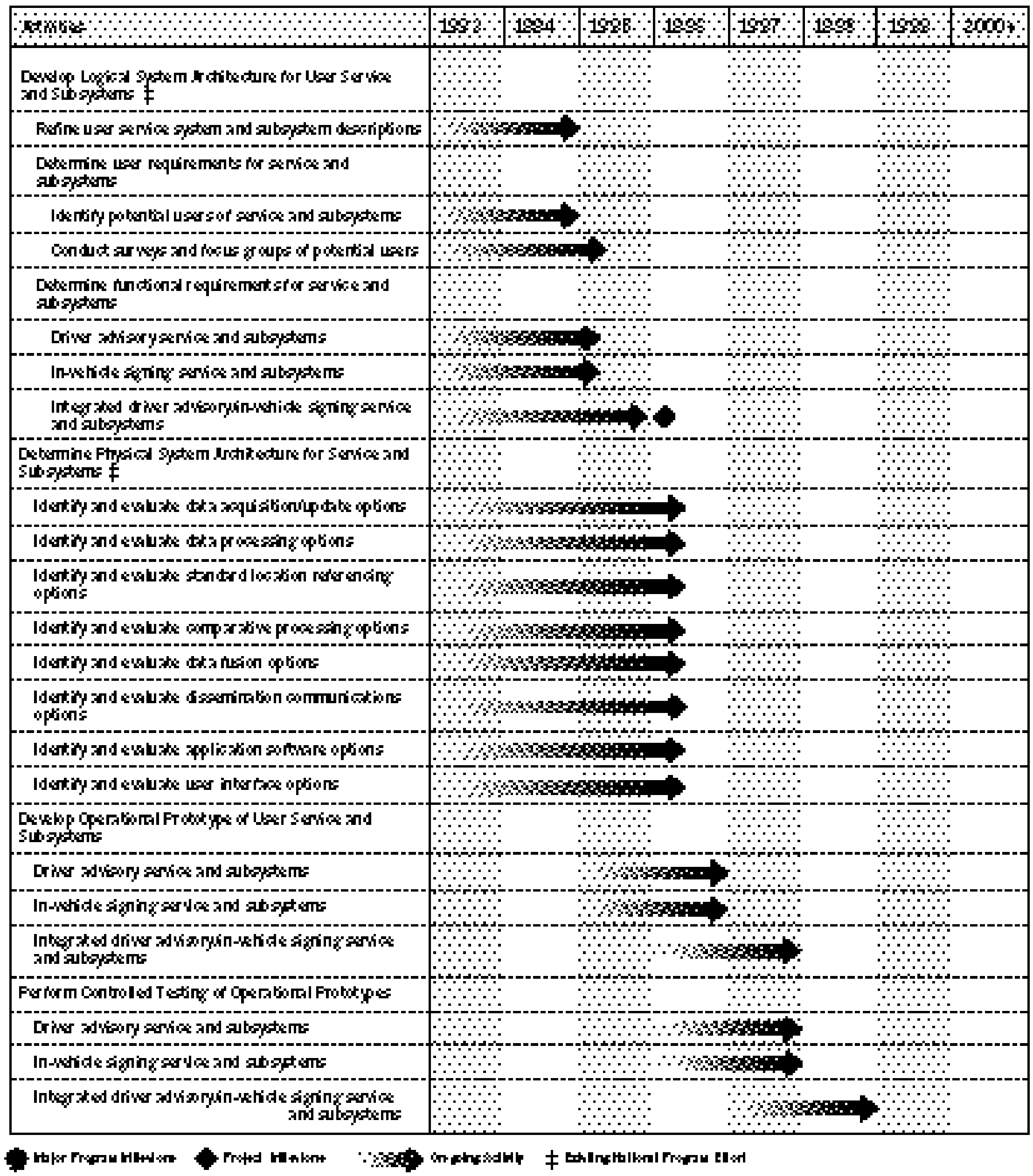
Pre-Trip Travel Information contd



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

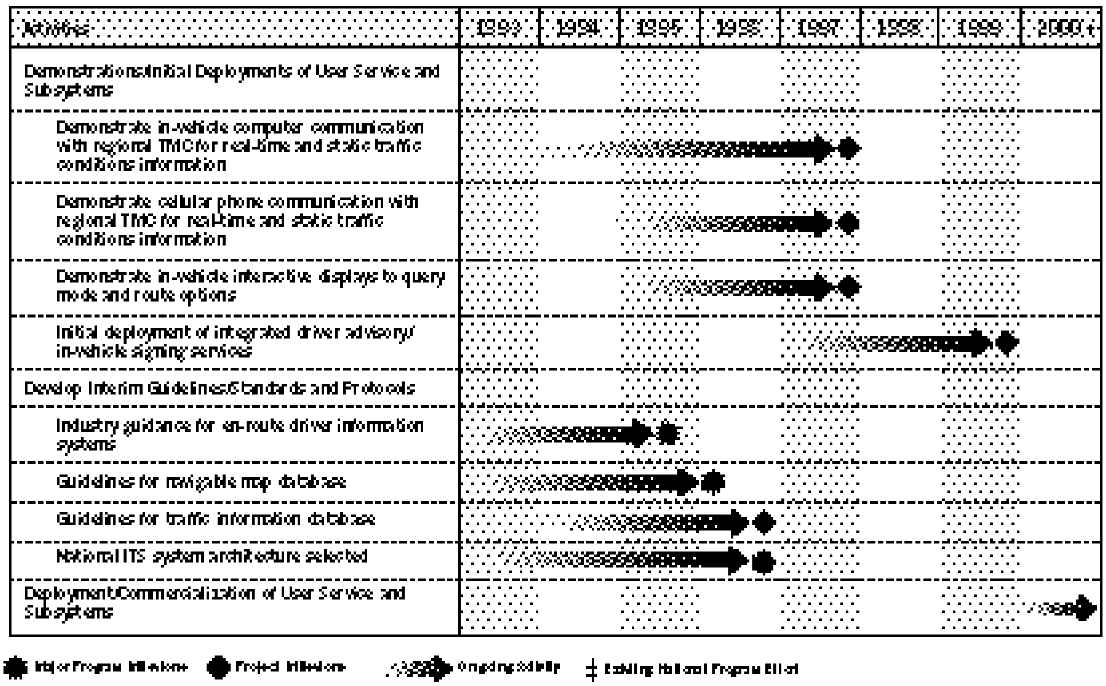
En-Route Driver Advisory



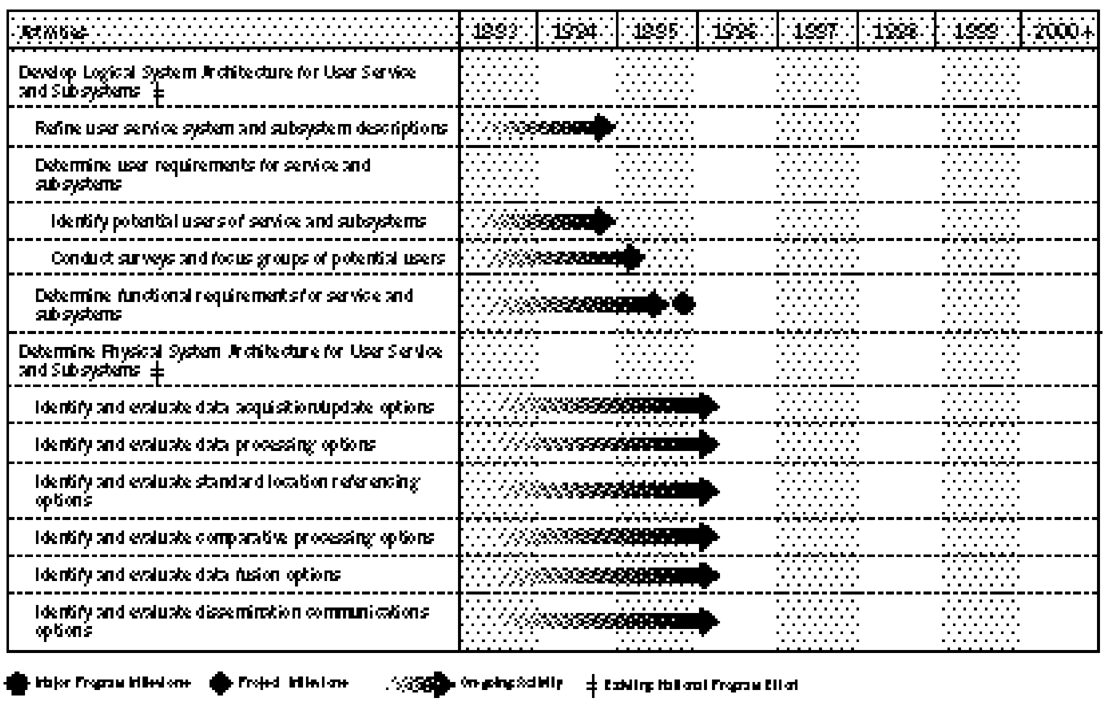
Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

En-Route Driver Advisory cont'd



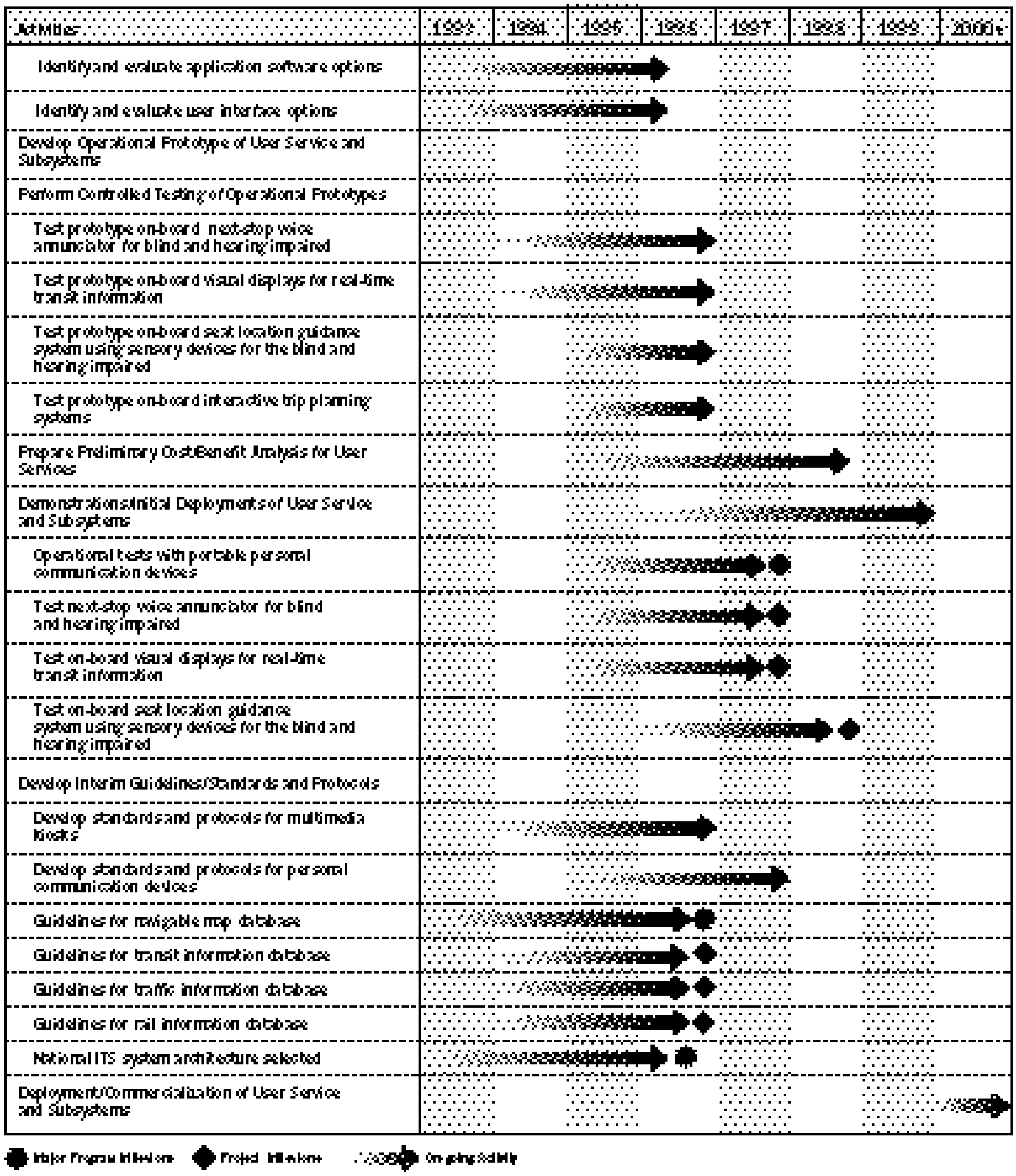
En-Route Transit Advisory



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

En-Route Transit Advisory cont'd



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

Traveler Services Information

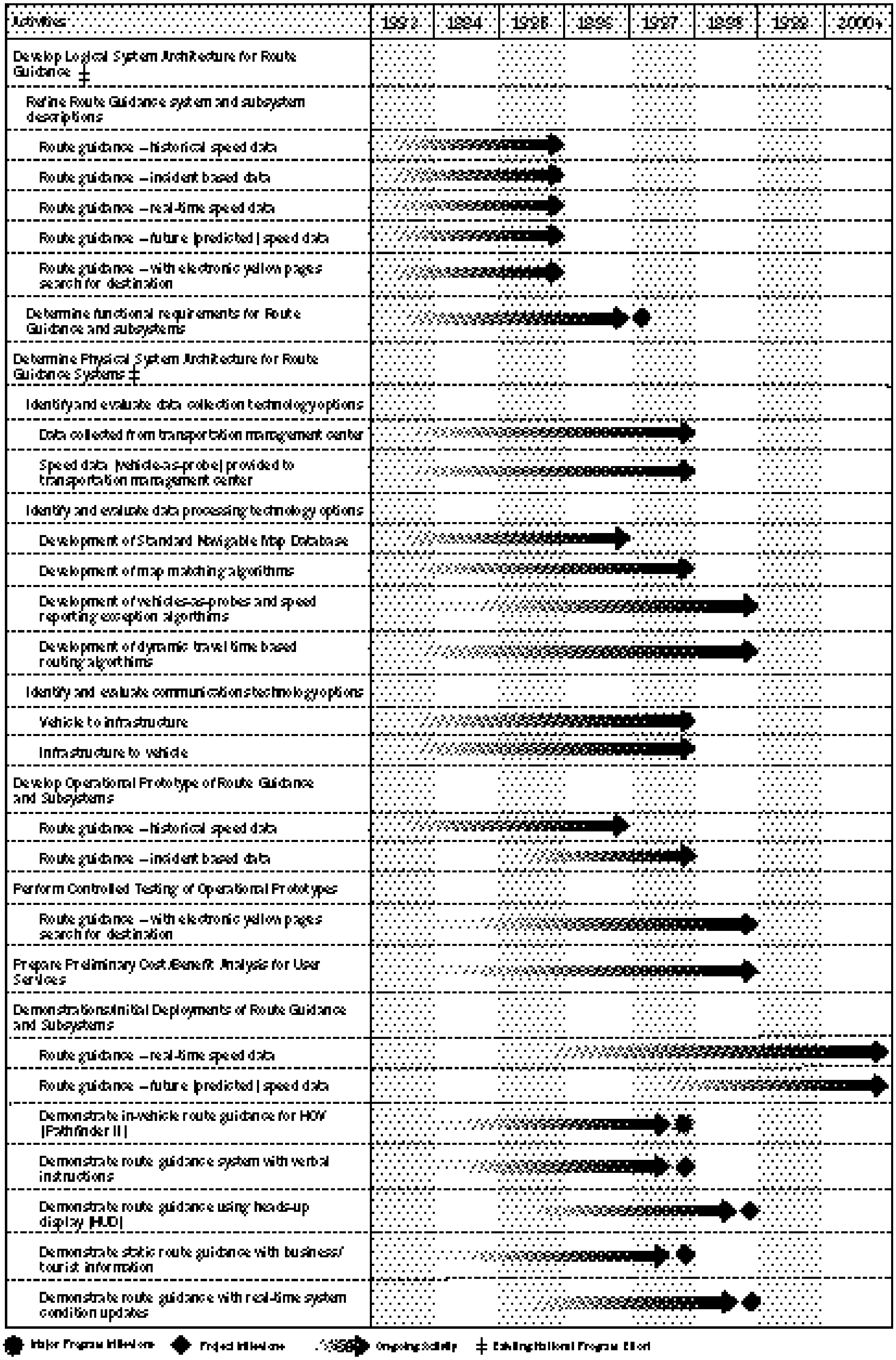
Activities	1993	1994	1995	1996	1997	1998	1999	2000+
Develop Logical System Architecture for User Service and Subsystems ‡								
Refine user service system and subsystem descriptions								
Determine user requirements for service and subsystems								
Identify potential users of service and subsystems								
Conduct surveys and focus groups of potential users								
Determine functional requirements for service and subsystems								
Determine Physical System Architecture for Service and Subsystems ‡								
Identify and evaluate data acquisition/update options								
Identify and evaluate data processing options								
Identify and evaluate standard location referencing options								
Identify and evaluate comparative processing options								
Identify and evaluate data fusion options								
Identify and evaluate dissemination communications options								
Identify and evaluate application software options								
Identify and evaluate user interface options								
Develop Operational Prototype of User Service and Subsystems								
Perform Controlled Testing of Operational Prototypes								
Prepare Preliminary Cost/Benefit Analysis for User Services								
Demonstrations/Initial Deployments of User Service and Subsystems								
Interactive version of electronic yellow pages with scan-select feature								
Enhanced interactive electronic yellow pages with printed route itinerary (static)								
Enhanced interactive electronic yellow pages with printed route itinerary (real-time)								
Develop Interim Guidelines/Standards and Protocols								
Guidelines for navigable map database								
National ITS system architecture selected								
Deployment/Commercialization of User Service and Subsystem								
Deploy private sector electronic yellow pages								
Deploy private sector electronic yellow pages linked to public information systems								

Major Program Milestone Project Milestone On-going Activity ‡ Existing National Program Effort

Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

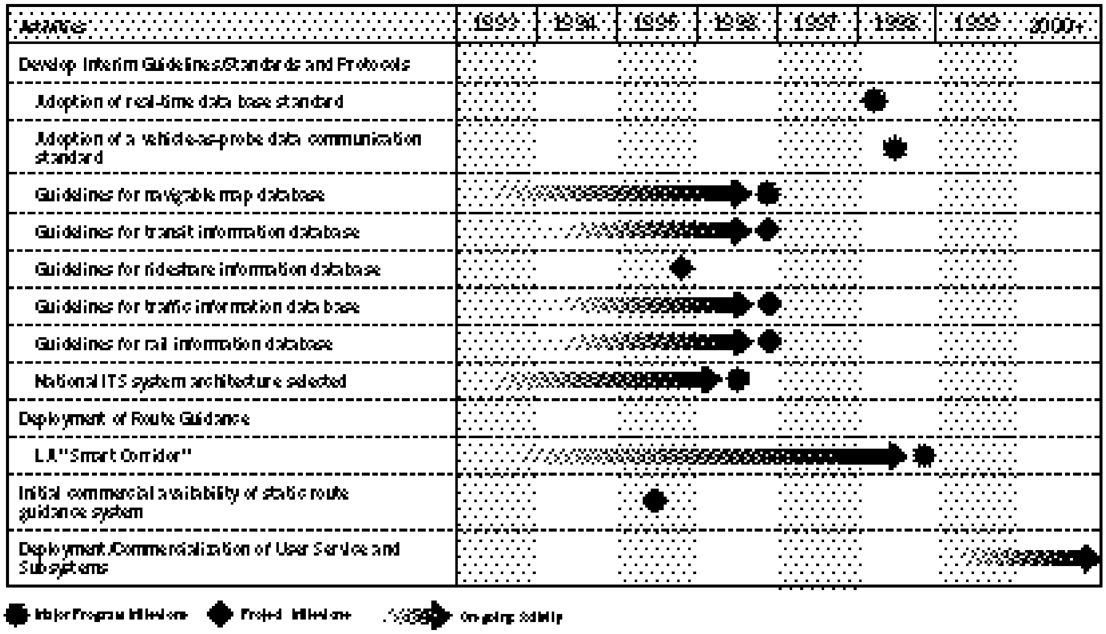
Route Guidance



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

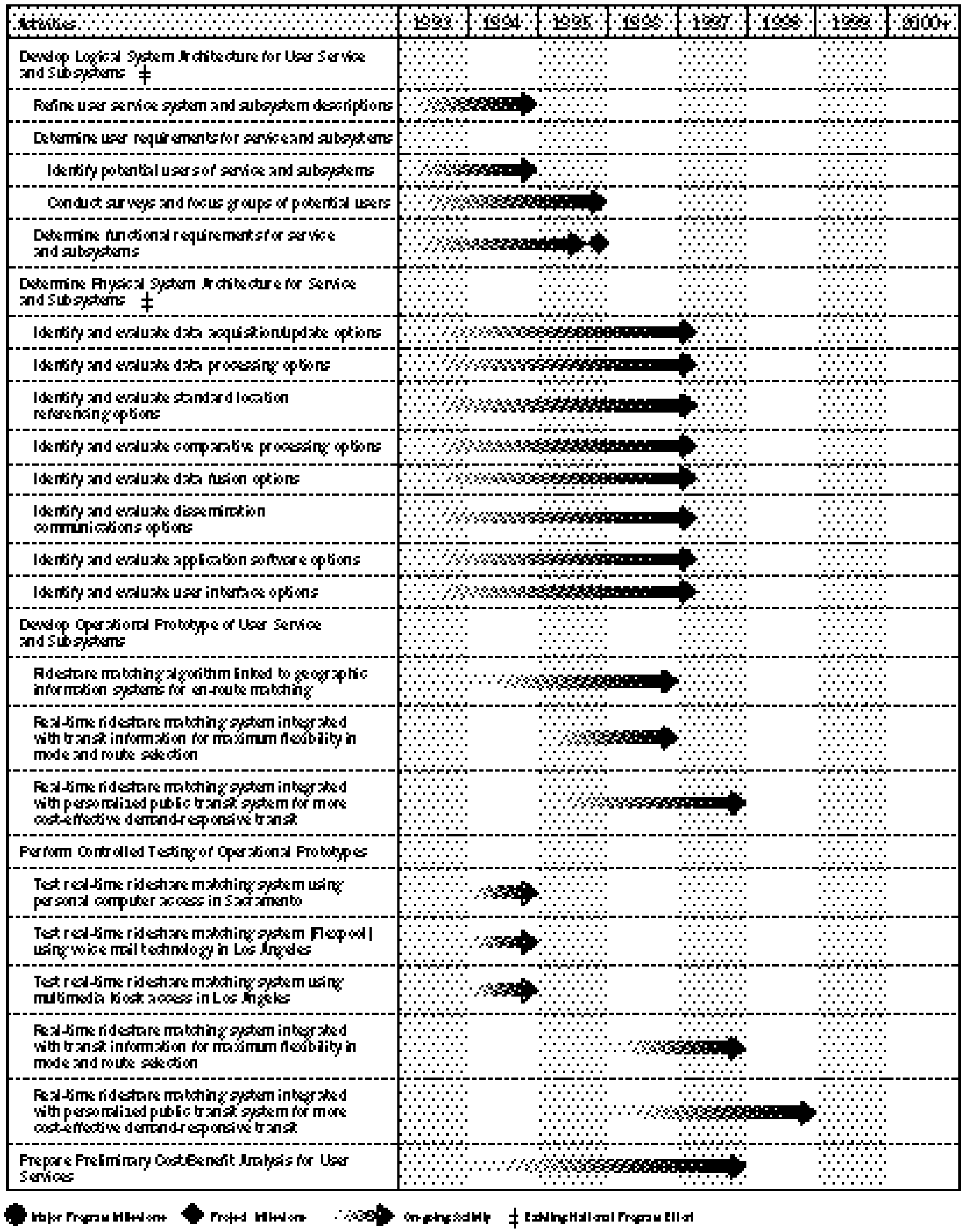
Route Guidance cont'd



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

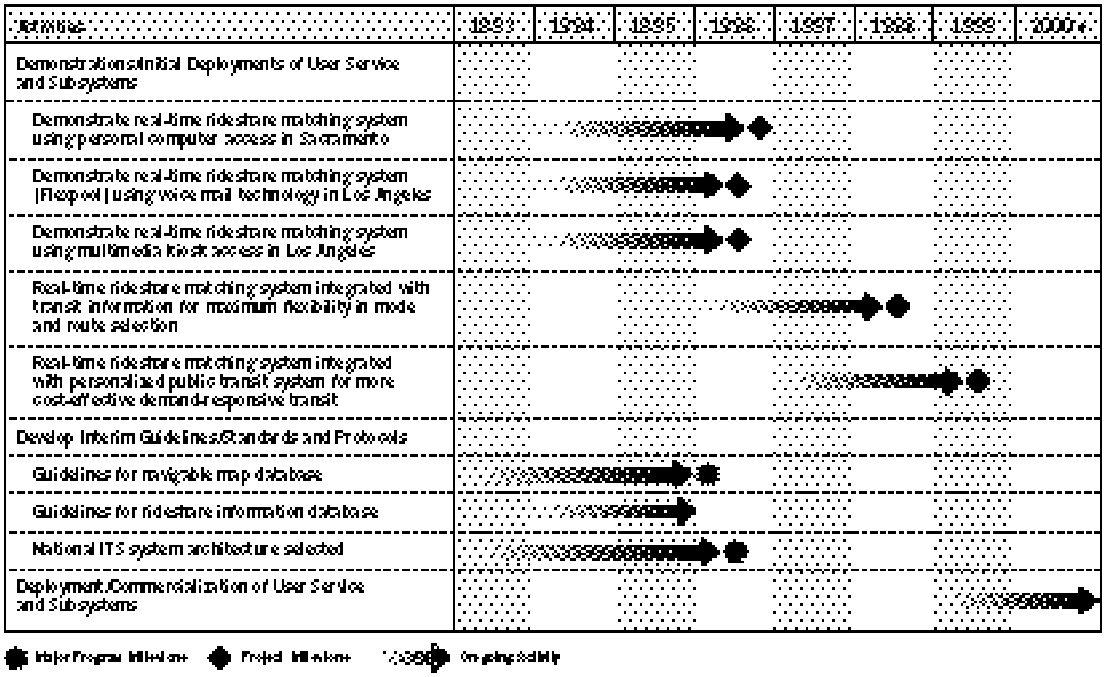
Ride Matching and Reservations



Transportation Information Services

Smart Traveler/Modal Services - Activity Charts

Ride Matching and Reservations contd



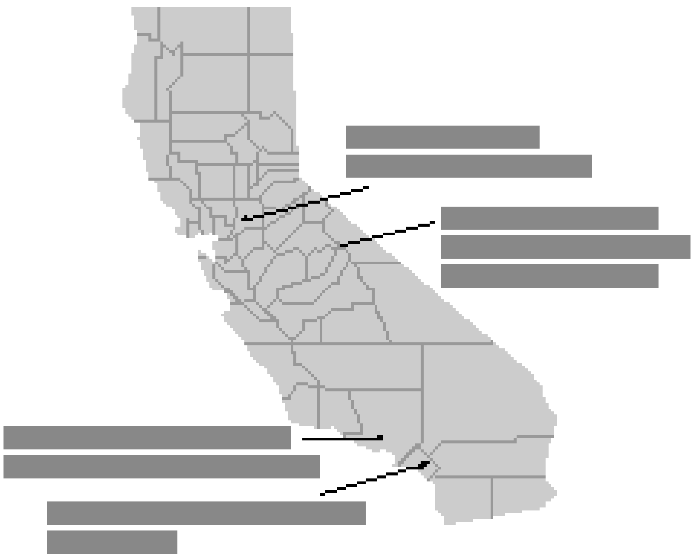
Transportation Information Services

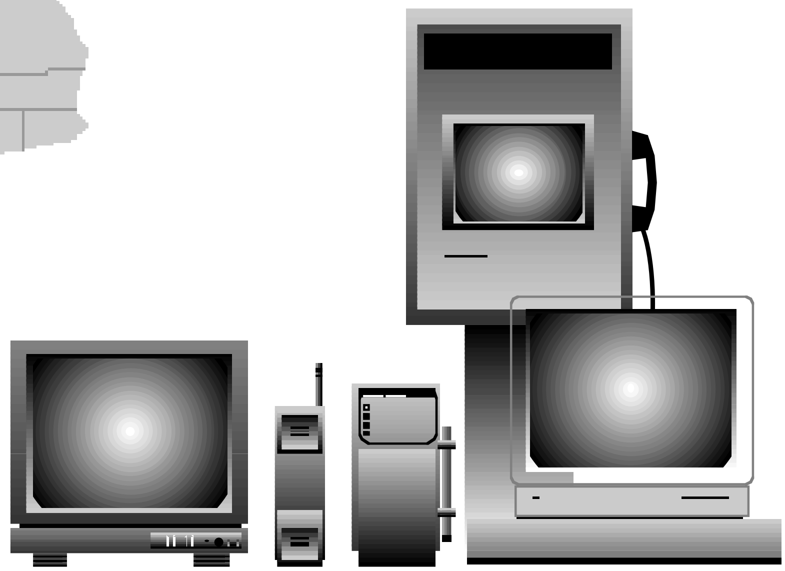
Smart Traveler/Modal Services - Project Highlights

A Travel Technology Project

TravInfo, a large-scale FHWA-sponsored operational test, being conducted in the San Francisco Bay Area, is an early model of a merged information system. TravInfo is designed to collect data from multiple transportation-related sources including: airline schedules; transit schedules, routes and fares; intercity rail schedules and fares; CHP computer-aided dispatch systems; Freeway Service Patrol reports; Transportation Management Centers (TMCs), and many others. The data will be collected, processed and made available to system users. The users, including the original information providers, can access the information in whatever detail their operation requires. Private vendors may use the data as a device to market transportation services. The evaluation of the test will include user opinion of private sector services, and the effects the use of the information has on the system's overall efficiency.

The success of the operational tests and fully functional demonstrations will be used to initiate deployment of a full function Advanced Transportation Management Information System (ATMIS) throughout California.





Cable TV/Cellular Phone/Palm-top Computer/Desk-top Computer/Infor mation Kiosk

Transportation Information Services

Travel Substitution - Scope

In addition to the movement of people and goods, the transportation system includes the movement of information and services. Rapid advancements in telecommunications technology are leading towards the fulfillment of Caltrans' vision for California's transportation future wherein telecommunications either enhance or substitute for the mobility of people and goods. This new approach to mobility, challenges transportation system managers to adequately plan for the telecommunications infrastructure as they would for other modes of transportation.

Telecommunications technology is essential to successful Transportation Demand Management (TDM) strategies that Caltrans is using to address traffic congestion, air quality issues and energy conservation, while increasing the mobility potential of Californians without an increase in motor vehicle trips. Specific travel substitution areas being addressed by the ATS Program include:

- Telecommuting
  (Home and Telework Centers)
- Teleconferencing
- Teleshopping
- Telebanking
- Tele-education

The five-year horizons for the deployment of new technologies are challenging Caltrans to establish a systematic, phased plan of action towards achievement of goals and objectives relative to deployment. Currently, the Caltrans Office of Transportation Demand Management has been following a strategy oriented towards determining the trip-making behavior associated with teletrip substitution as a TDM strategy. The strategy involves research, feasibility studies, demonstration projects and other activities aimed at determining the utility of information transfer towards meeting the department's objectives.

Telecommuting represents a major innovative strategy in the new process because it expands the definition of home-to-work transportation to include telecommunications.

Several projects have been undertaken to test the effectiveness of telecommunications as a TDM strategy. These projects emphasize cooperative arrangements between Caltrans, other agencies, developers and the business community.

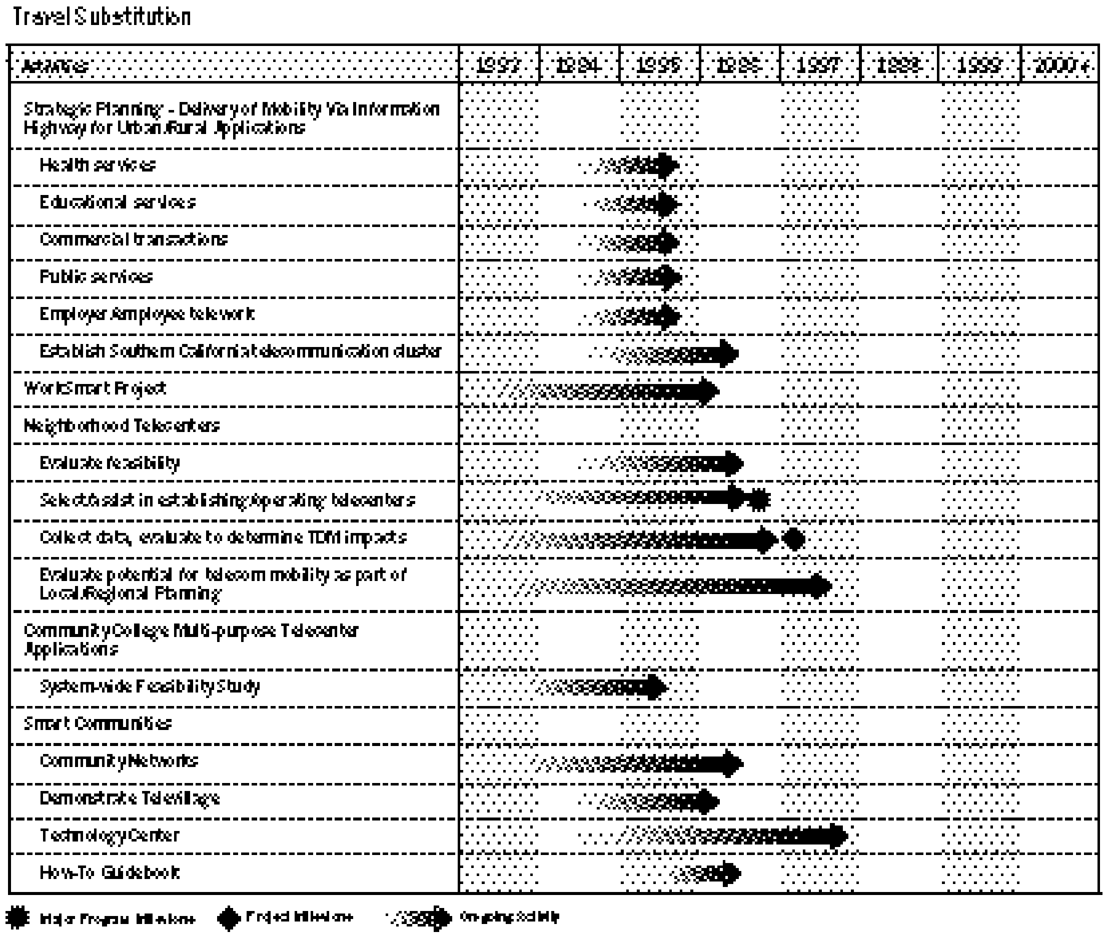
Public utilities are supportive of the use of telecommunications technologies. Recent announcements by public utilities that all digital networks will be in place by 1997 will help set the stage for the deployment of a full-service broadband infrastructure in California.

Caltrans Telecommunications Mobility Projects

(All projects involve extensive public and private sector partnerships)

Transportation Information Services

Travel Substitution - Activity Chart



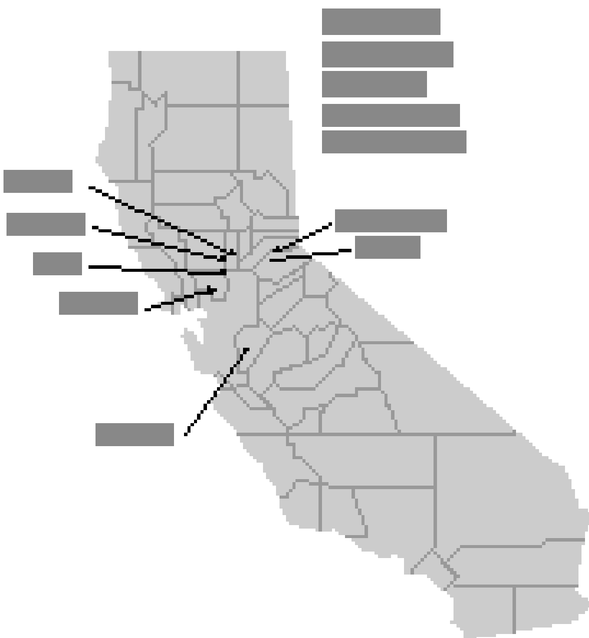
Transportation Information Services

Travel Substitution - Project Highlights

The Work Smart Project provides the opportunity to fulfill transportation needs through telework by capturing trends in office facility design and operations.

Organizations that utilize new information technologies and management practices to develop a wide array of time/space work options that expand the boundaries of the conventional workplace can achieve what seem like contradictory goals: reducing costs, increasing performance, enhancing flexibility, and improving air quality and traffic congestion. This project will help organizations identify which workplace and workforce strategies make the most sense for meeting their needs, and assist in developing plans for implementing the evolving workplace and managing it over time.

New approaches to mixed-use communities that are fully accessible via the information superhighway are anticipated.



Davis Community Network

Caltrans is working with UCD to develop a testbed community network which will support telework, telelearning, teleshopping, telemedicine, telebanking, electronic democracy, etc., as a means of determining the effect of such a network on trip demand.

The project requires a feasibility study of three new networking technologies for support of the community network: Integrated Services Digital Network (ISDN), wireless and cable television. Negotiations are underway with vendors for each type of technology. The project also coordinates the development of the community network and training of the network users. At least 500 test participants must be initially recruited in order to provide a sufficient research population. Up to 2,000 community network users (not necessarily directly involved in the research effort) are expected by January 1996.

The Davis Community Network Project is researching wide area networking amenities and support for neighborhood telecen- throughout the Central Valley and ills (see map). Instead of driving to , people are encouraged to walk, bike, de a shuttle to a neighborhood office ity which could provide computers, rs, faxes, phones with voice mail, as as support for electronic mail and teleconferencing. These facilities sup- ent the use of home-based telecommu- ions devices.

Caltrans has assumed a leadership role in the development and implementation of telecommunications strategies.

UC Davis is researching various aspects of telecommuting.

ADVANCED VEHICLES

Advanced Vehicles is a package of smart vehicles whose operation is based on communications technologies; alternative vehicles; and high-speed systems, such as rail and air.

Smart Vehicles

- *On-Board Safety Monitoring*
- *Personalized Public Transit*
- *Longitudinal Collision Avoidance*
- *Lateral Collision Avoidance*
- *Intersection Crash Warning and Control*
- *Vision Enhancement for Crash Avoidance*
- *Impairment Alert*
- *Pre-crash Restraint Deployment*
- *Fully Automated Vehicle Operations*
- *Transit, School Bus and Commercial Operations*

Alternative Vehicles

- *High-Speed Ground Transportation*
- *Air Transportation*

The milestones, scope of services, activities and specific project highlights for Advanced Vehicles are discussed on the following pages.

Advanced Vehicles

1993	1994	1995	1996	1997	1998
				Personal Public Transportation Demonstration	
	Vehicle Guidance and Control Second Phase Development			Collision Warning Demonstration (Automobiles)	Integrated "Smart Bus" Prototype
	AHS Contract Award		National ITS System Architecture Selected	Longitudinal/Lateral Control Demo (Autos/Trucks)	
	AHS Definition Phase Launched		AHS Test Track Facility		
			Standard Navigable Map Database	AHS demo	
1993	1994	1995	1996	1997	1998

Advanced Vehicles

Smart Vehicles - Scope

Smart vehicle applications generally fall into these broad user services categories:

- **On-board Safety Monitoring**

On-board safety monitoring service focuses on enhancing safety for commercial motor carrier transportation, although this technology will be available for private automobiles also.

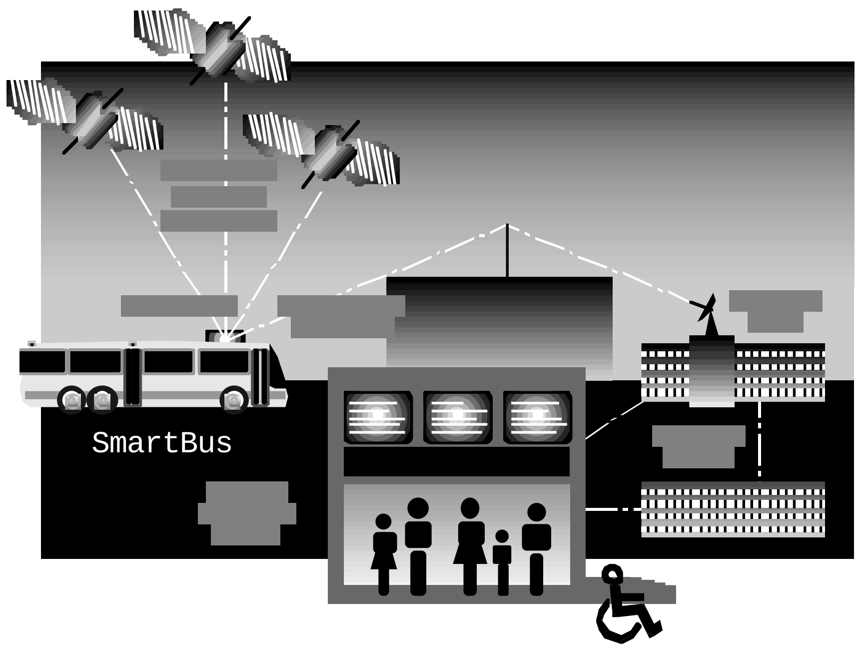
Such capabilities apply to pre- and post-trip inspections, as well as warnings while underway. Communicating this safety information while in motion is a part of the commercial vehicle preclearance service and automated roadside safety inspection services.

The most effective safety program will occur if the automated roadside safety inspections, commercial vehicle electronic clearance, and on-board safety monitoring services operate interactively and are compatible with carrier on-board safety systems. Implementation of all three services simultaneously is achievable as long as the ITS system architecture provides for phased deployment.

- **Personalized Public Transit**

Flexibly routes transit vehicles to provide cost-effective personalized services which can be truly competitive with the private auto.

These transit vehicles can consist of small buses, vans, taxicabs, or other small shared-ride vehicles. They can essentially provide door-to-door service, expanding a route's coverage area in less populated locations and neighborhoods. This type of service can offer shared-ride transportation at lower cost and with greater convenience than conventional fixed route transit. The principal characteristic of this service is that multiple passengers share vehicles. Small publicly or privately operated vehicles operate on demand assignments to pick up passengers who have requested service and deliver them to their destinations.



- **Longitudinal Collision Avoidance**

Longitudinal collisions involve head-on and rear-end collisions between vehicles, including collisions involving pedestrians.

Longitudinal collision avoidance will help reduce the number and severity of collisions. This involves sensing potential collisions, prompting a driver's avoidance actions, and temporarily controlling the vehicle to help minimize damage and injury. Longitudinal collision avoidance includes sensing obstacles both in front of, and behind, the vehicle. The forward-looking sensors will likely be active all the time, whereas the rear-looking sensors are expected to be activated whenever the vehicle is in reverse. The rear-looking sensor will aid in preventing backup accidents in parking lots and restricted areas, and will be especially helpful where there is a high probability of pedestrian traffic behind or between vehicles.

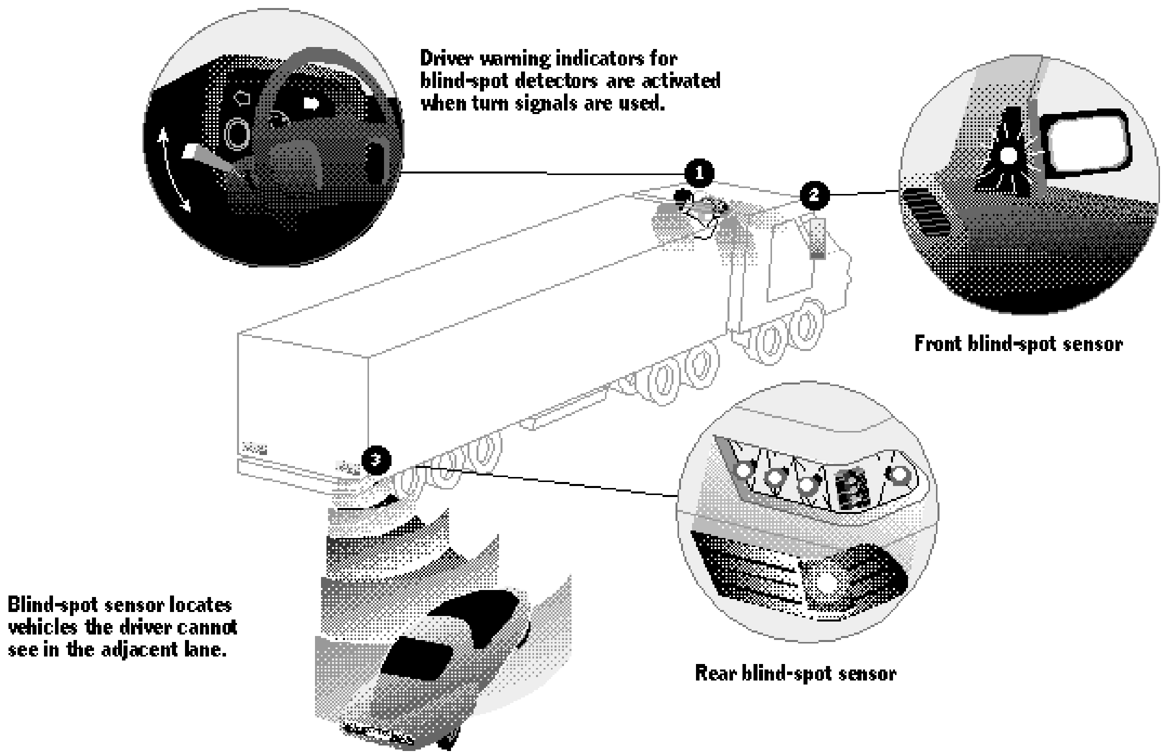
- **Lateral Collision Avoidance**

Lateral collisions involve vehicles leaving their own lane of travel while moving forward.

Lateral collision avoidance technology will help reduce the number of lateral collisions by providing crash warnings and controls for lane changes, blind spots and road departures. Lateral collisions include two-vehicle and single-vehicle collisions.

There are degrees of control to both types of crash warning and control capabilities. For lane changes, a situation display can continuously monitor a vehicle's blind spot; drivers can be actively warned of an impending collision, and automatic control can effectively respond to situations very rapidly. For road departures, warning systems can cue a driver to an impending road departure; assist in lane keeping, and provide automatic control of steering and throttle in dangerous situations.

Collision warning systems, currently being tested, can be adapted to longitudinal control.



Advanced Vehicles

Smart Vehicles - Scope

The goal of this effort is to ensure safe, alert drivers.

- ### Intersection Crash Warning and Control

Accident avoidance at intersections where there is a frequency of accidents and violations involving ambiguous right-of-way laws.

Intersection collision avoidance closely relates to two other collision avoidance services: lateral and longitudinal collision avoidance. Intersection collision avoidance could combine information about crossing traffic with information about signals ahead, improving situational awareness.

- ### Vision Enhancement for Crash Avoidance

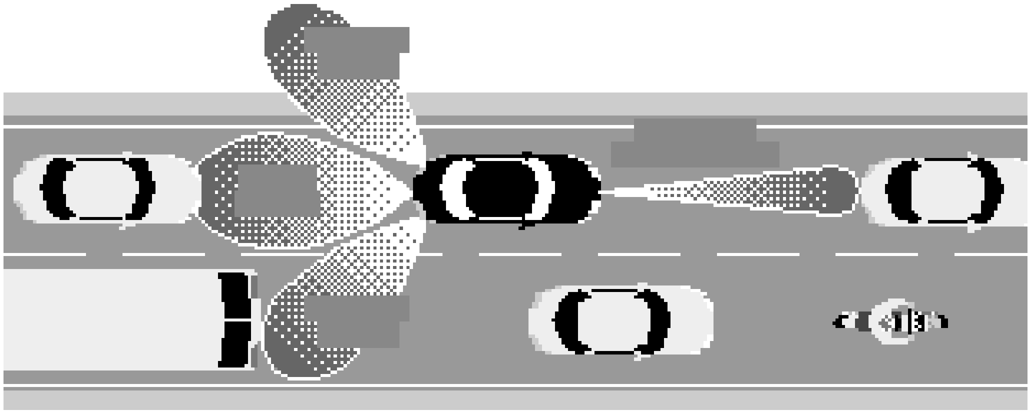
Improves the driver's ability to see objects in and around the travelway.

Improved visibility would allow the driver to avoid potential collisions with other vehicles or obstacles in the line of travel and help the driver to comply with traffic signs and signals. This service requires in-vehicle equipment for sensing potential hazards (such as fog, dust, and smoke), processing this information, and displaying it so that it is useful to a driver.

- ### Impairment Alert

Provides warnings regarding the condition of the driver, vehicle, and roadway infrastructure.

In-vehicle equipment could unobtrusively gauge a driver's condition and provide a warning of drowsiness or otherwise impaired conditions. This service would also internally monitor critical components of a vehicle beyond standard oil pressure and engine temperature. Lastly, equipment within a vehicle could detect unsafe system conditions in real-time, including bridge icing, standing water on a roadway or rail track discontinuity.



- **Pre-Crash Restraint Deployment**

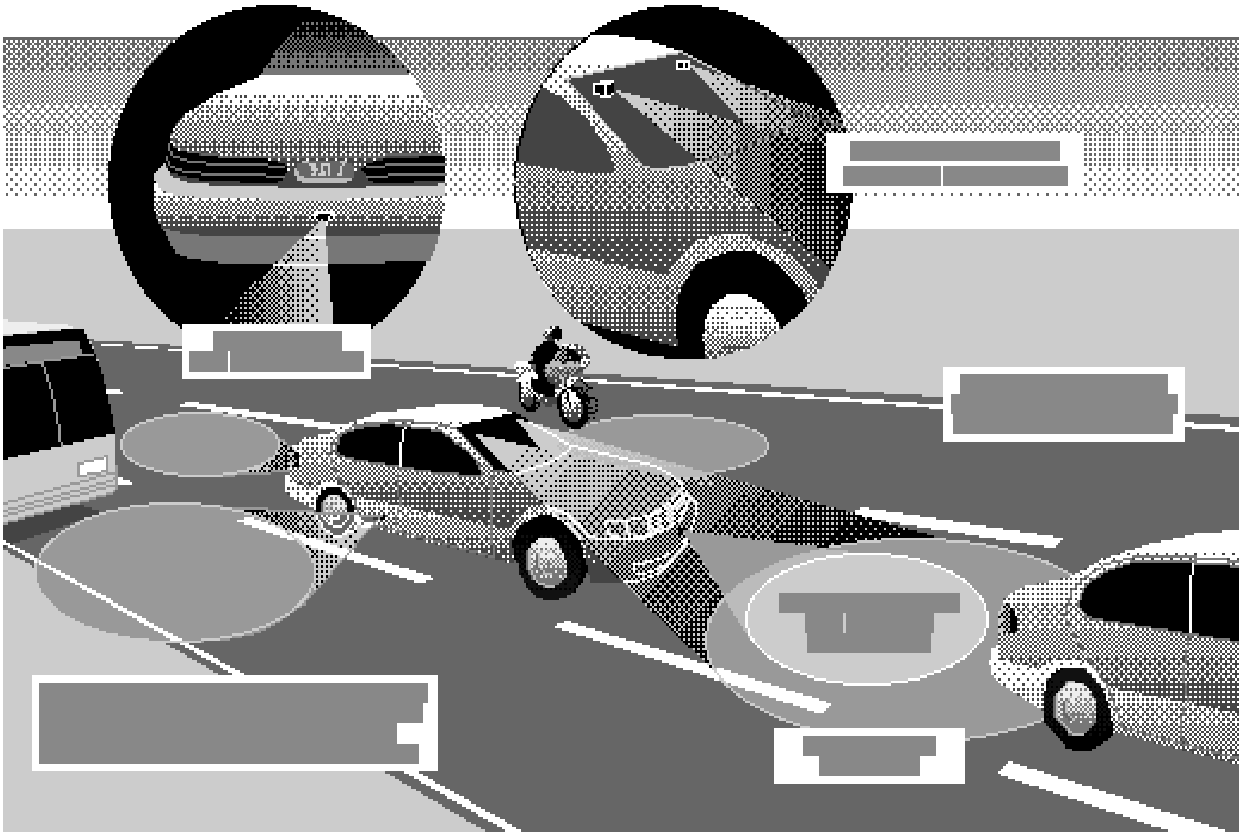
  This technology is applied to devices which anticipate an imminent collision and activate passenger safety mechanisms prior to collision, based on details of vehicles and/or objects involved.

Details can include velocity, mass, and direction of the vehicle and objects involved, as well as the number, location, and physical characteristics of any occupants. Responses include tightening lap-shoulder belts, arming and deploying air bags at an optimal pressure, deploying roll-bars, and restraining wheelchairs.

- **Fully Automated Vehicle Operations**

  Fully automates vehicles on instrumented facilities, significantly improving today's safety, efficiency, and comfort standards.

Automated vehicle operations remain an ITS objective. Drivers could buy vehicles with the necessary instrumentation or retrofit an existing vehicle. Vehicles that are incapable of automated operation could continue to operate on conventional facilities for many years.



Advanced Vehicles

Smart Vehicles - Scope

- **Transit, School Bus, and Commercial Operations**

Initial research by Caltrans into vehicle control and vehicle automation has been in automobiles, primarily due to the lower cost of experimenting with autos as compared to buses or trucks. However, Caltrans recognizes that the early deployment of automation and automation technologies will probably need to be in transit and commercial operations.

This will be driven by the fact that the most economic deployment in the early stages will be in the transit and commercial area, due to the lower relative cost of instrumenting commercial vehicles when compared to private automobiles. Caltrans' vision includes a full-scale, evolutionary approach to automation of transit, school buses, and commercial vehicles.

The evolutionary approach involves taking early results from sensor studies, lateral and longitudinal control studies, and related automobile research, and adapting and evolving that into a series of bus and truck research projects. That research moves from instrumentation of large vehicles to driver assistance in the form of collision warning (both lateral and longitudinal), and then to simple driver assistance (such as lane keeping assistance) and finally to full automation. The same approach will be used for transit, school buses, and commercial trucks. The transit automation research will be fully coordinated with the "smart bus" research and experiments to provide an integrated, incremental approach leading to warning, then assistance, and eventually, perhaps full automation.

Commercial trucks will follow a similar path giving the driver and owner increasing driver assistance and automation, also coordinated with the "smart vehicle" research that includes weigh-in-motion, electronic permits and fee collection, and automated fleet management.

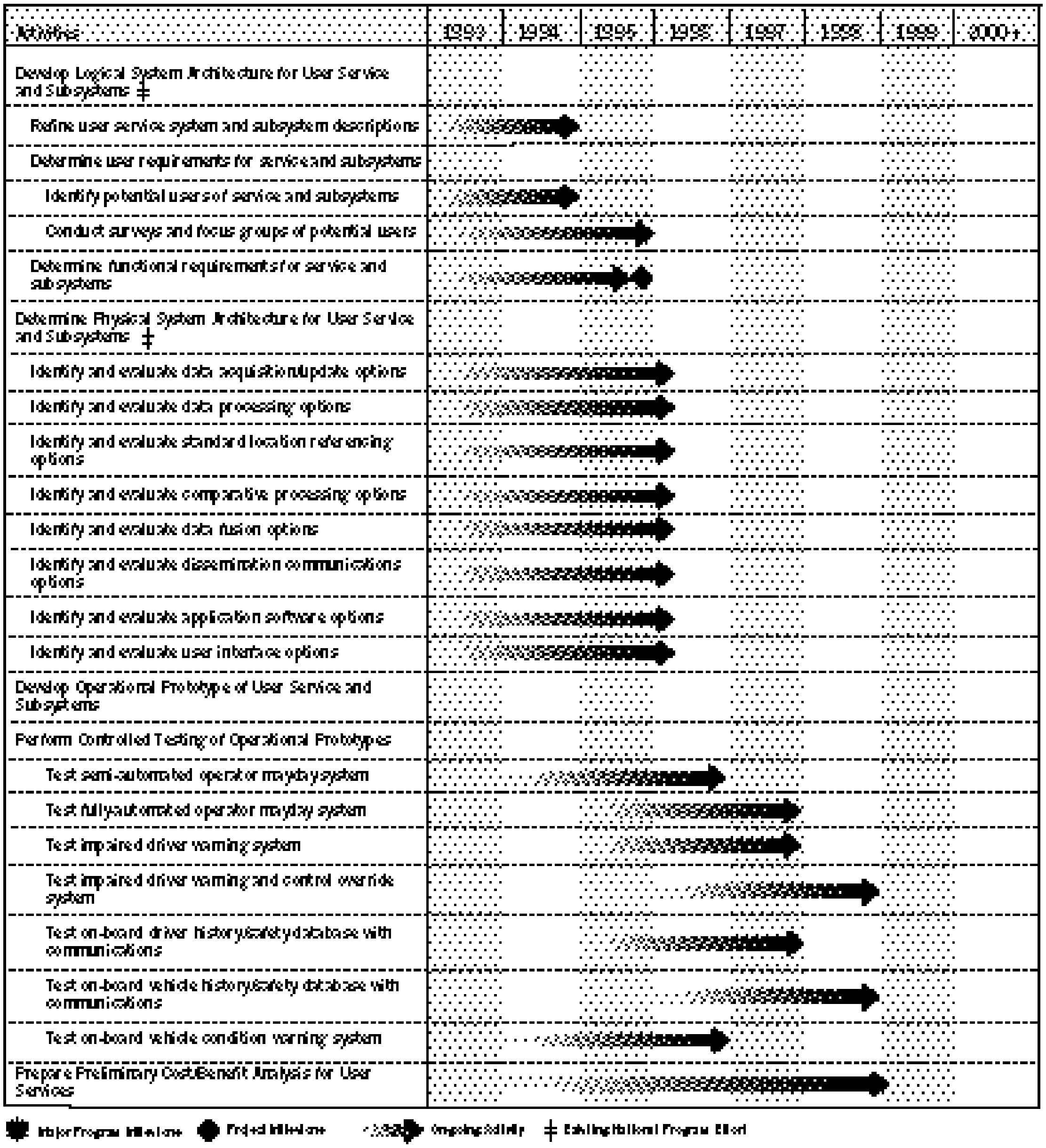
School bus automation will take a more conservative approach, with early research providing driver enhancements for both lateral and longitudinal collision warning, and fleet management, followed by partial automation of functions such as lane keeping. Full automation of school buses remains a topic that will require investigation to determine if it will be accepted because of the higher level of safety sensitivity involved with children on school buses. Technically, it is as feasible as transit automation, but public acceptance may evolve more slowly.

In all cases of transit, school buses, and commercial vehicles, the key is to build on automobile and other related research to develop an integrated, incremental approach, with each step adding features that will bring the commercial operators a clear advantage and return on investment. Features which may be salable on automobiles to the general driving public may not be marketable in the commercial arena unless there is a clear advantage to the commercial owner/operator.

Advanced Vehicles

Smart Vehicles - Activity Charts

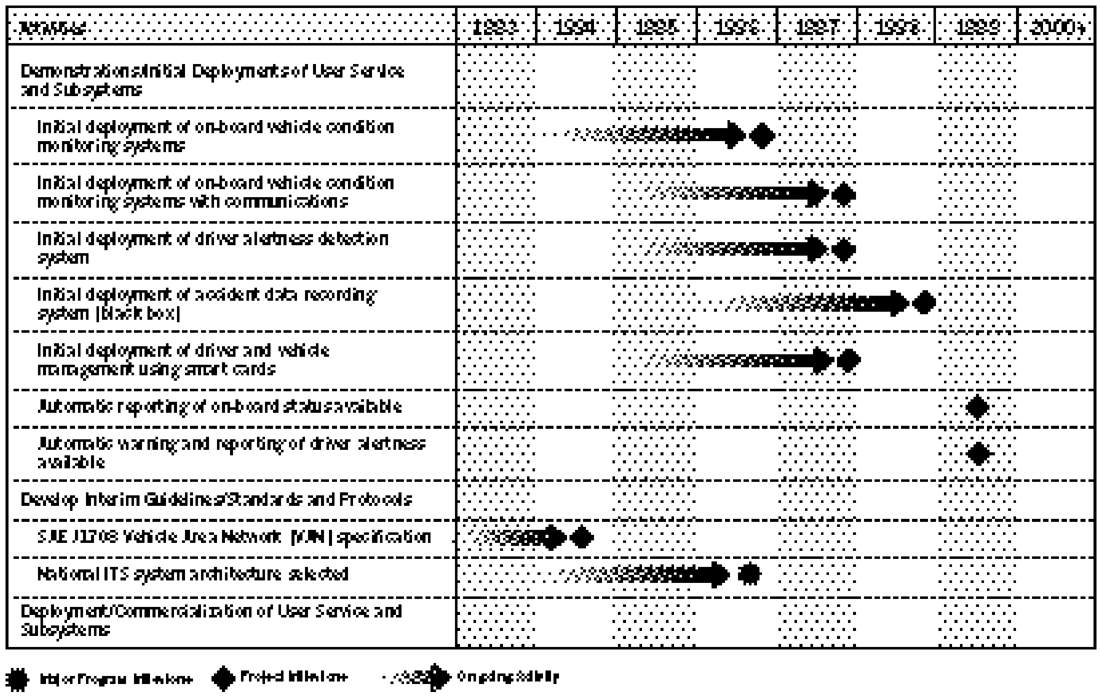
On-Board Safety Monitoring



Advanced Vehicles

Smart Vehicles - Activity Charts

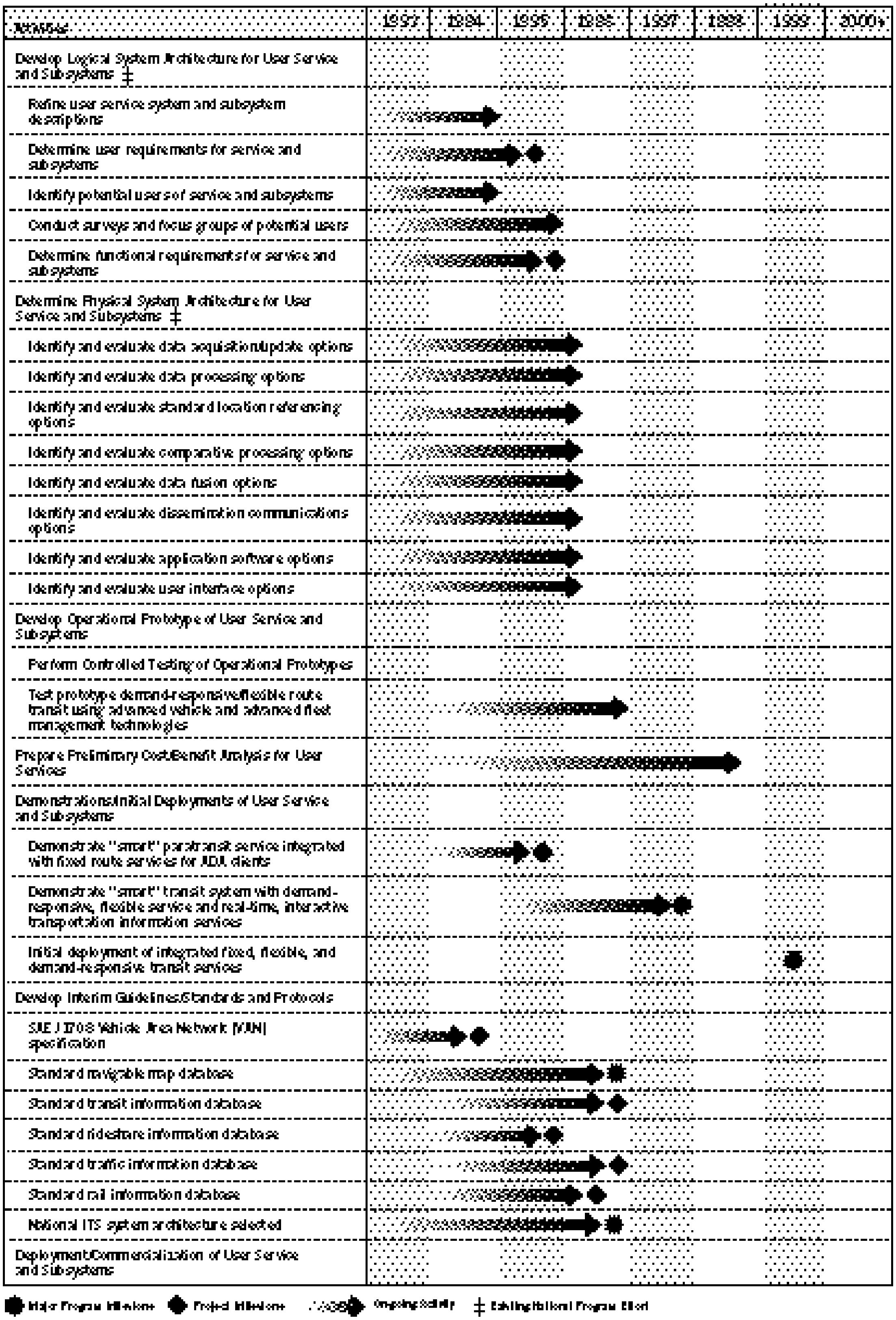
On-Board Safety Monitoring cont'd



Advanced Vehicles

Smart Vehicles - Activity Charts

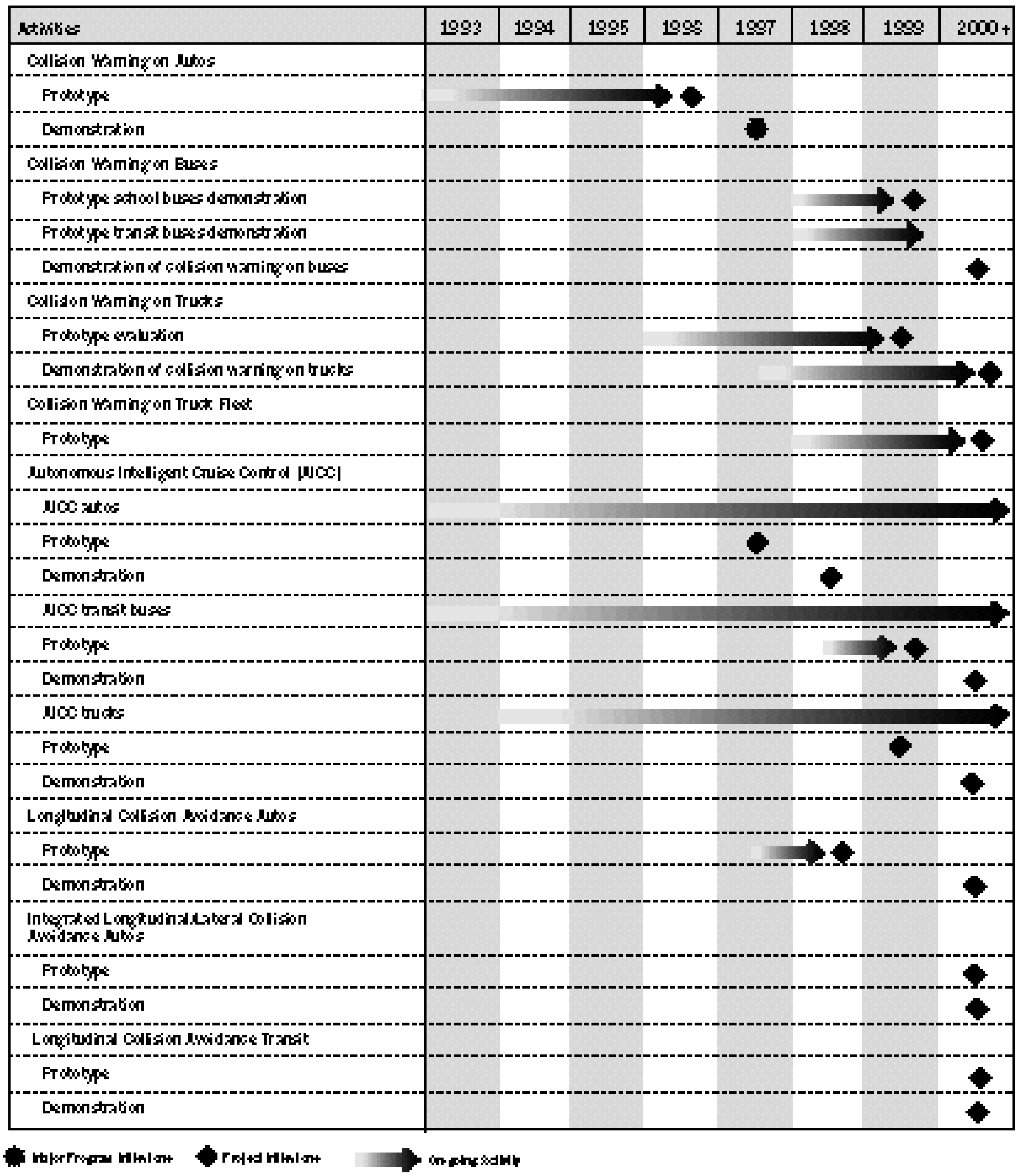
Personalized Public Transit



Advanced Vehicles

Smart Vehicles - Activity Charts

Longitudinal Collision Avoidance



Advanced Vehicles

Smart Vehicles - Activity Charts

Longitudinal Collision Avoidance contd

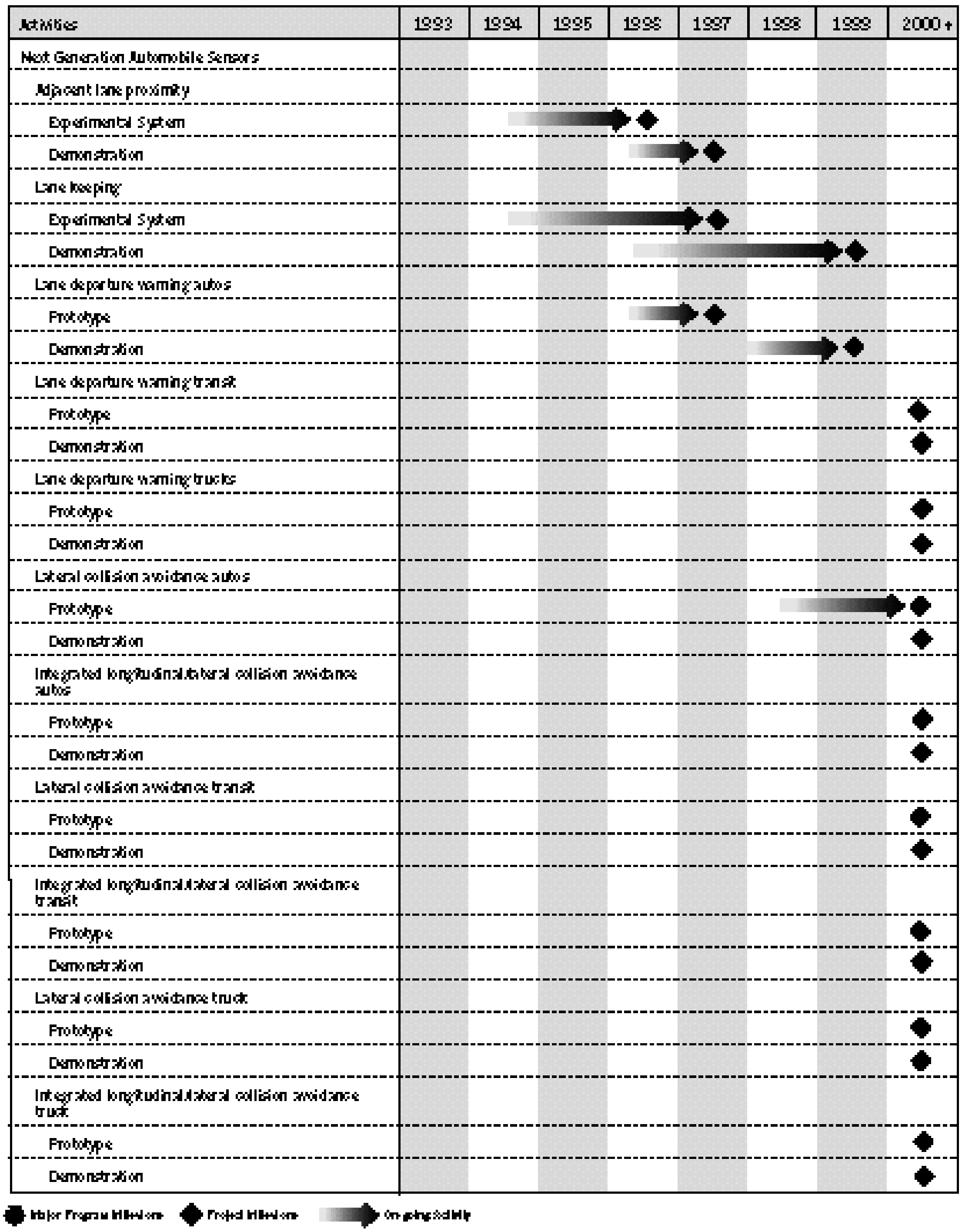
Activities	1993	1994	1995	1996	1997	1998	1999	2000+
Integrated Longitudinal/Lateral Collision Avoidance Transit								
Prototype								◆
Demonstration								◆
Longitudinal Collision Avoidance Truck								
Prototype							◆	
Demonstration								◆
Integrated Longitudinal/Lateral Collision Avoidance Truck								
Prototype								◆
Demonstration								◆

Major Milestone ◆ Project Milestone On-going Activity

Advanced Vehicles

Smart Vehicles - Activity Charts

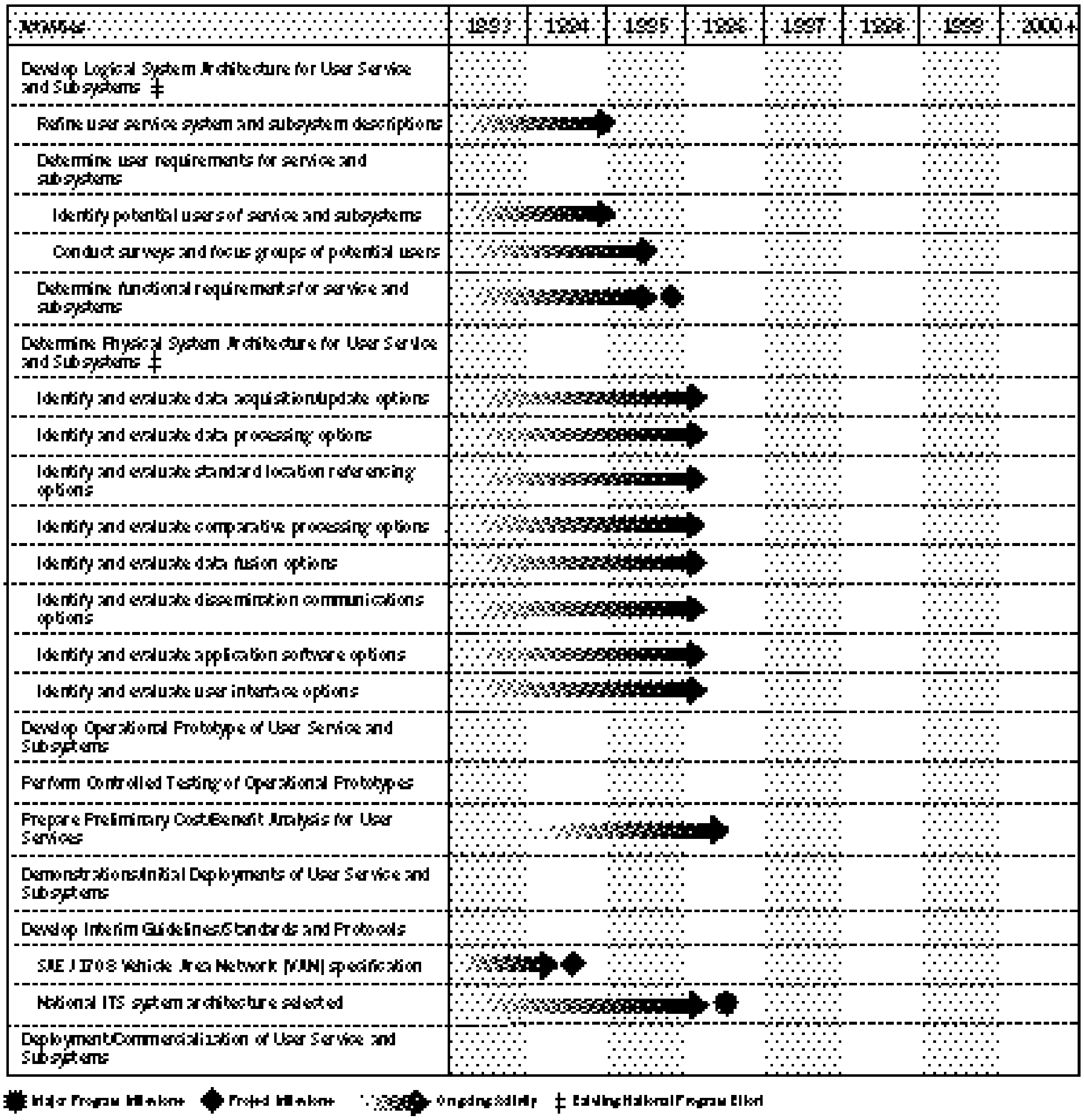
Lateral Collision Avoidance



Advanced Vehicles

Smart Vehicles - Activity Charts

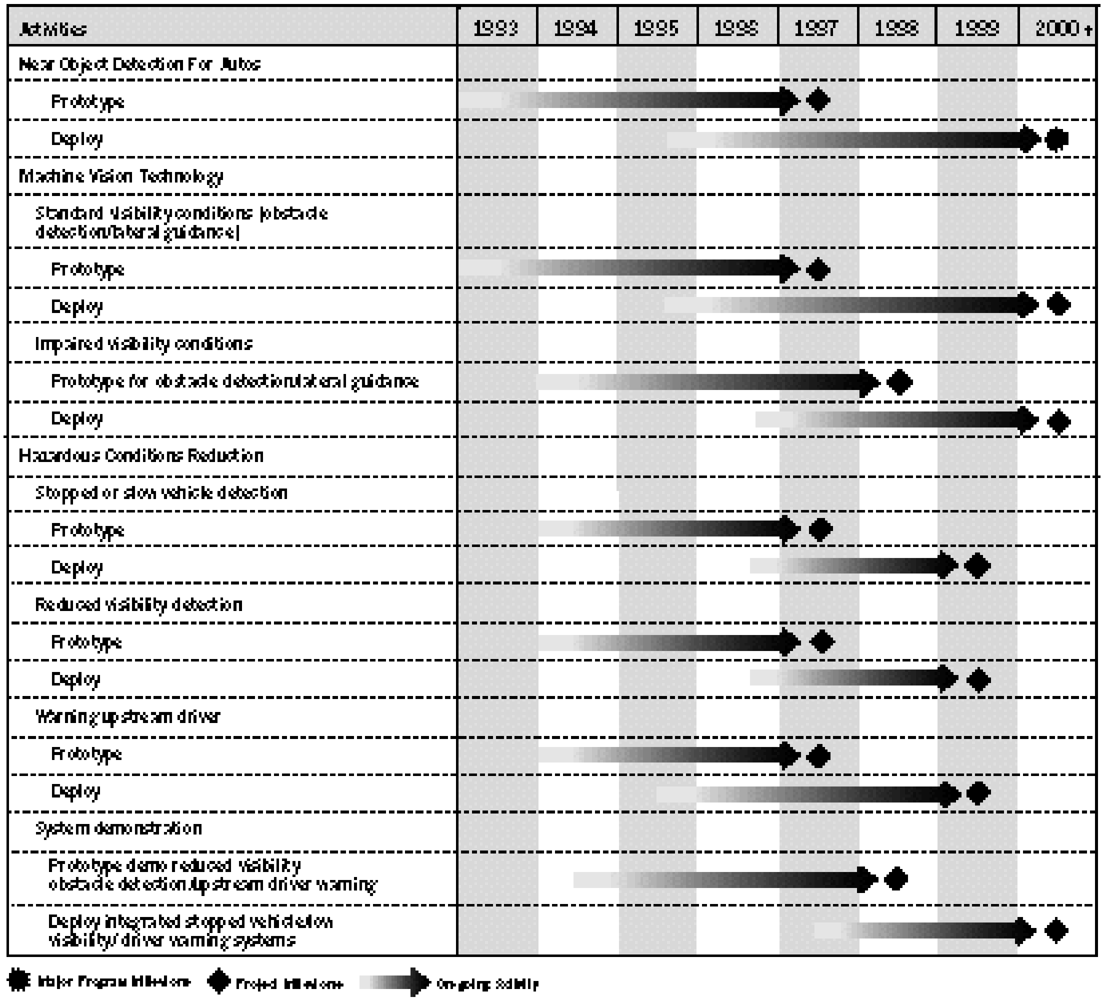
Intersection Crash Warning and Control



Advanced Vehicles

Smart Vehicles - Activity Charts

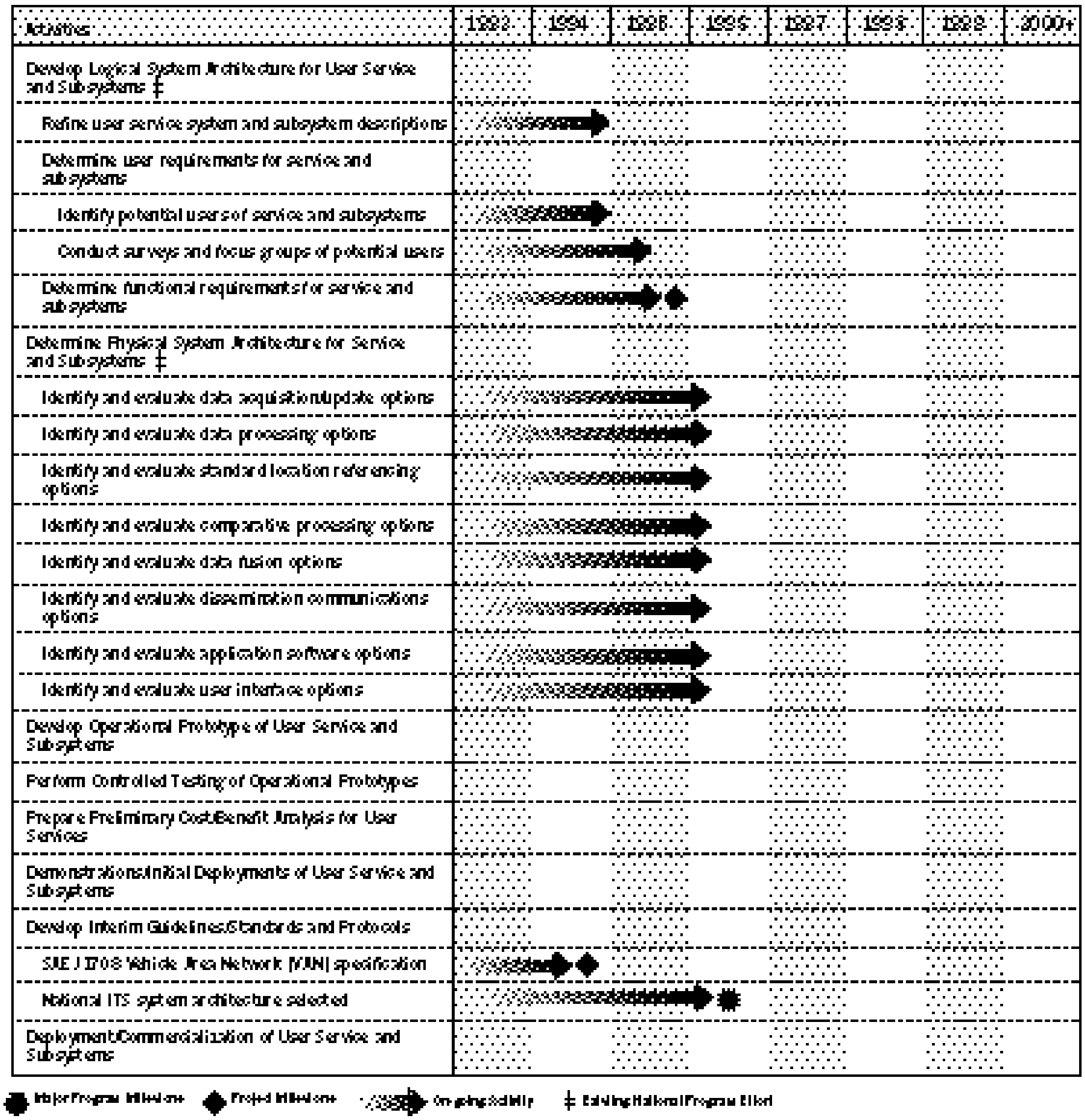
Vision Enhancements



Advanced Vehicle

Smart Vehicles - Activity Charts

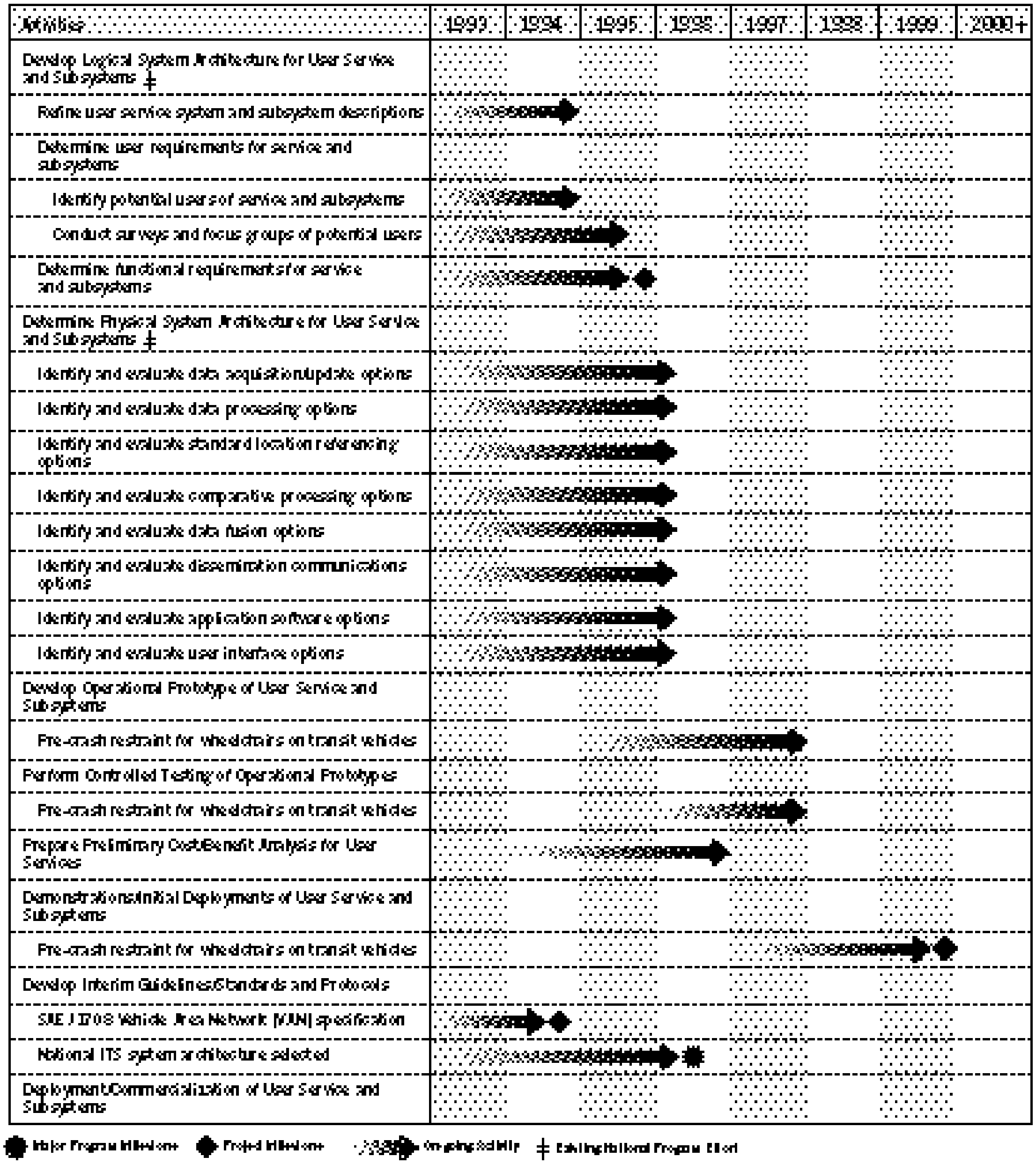
Impairment Alert



Advanced Vehicles

Smart Vehicles - Activity Charts

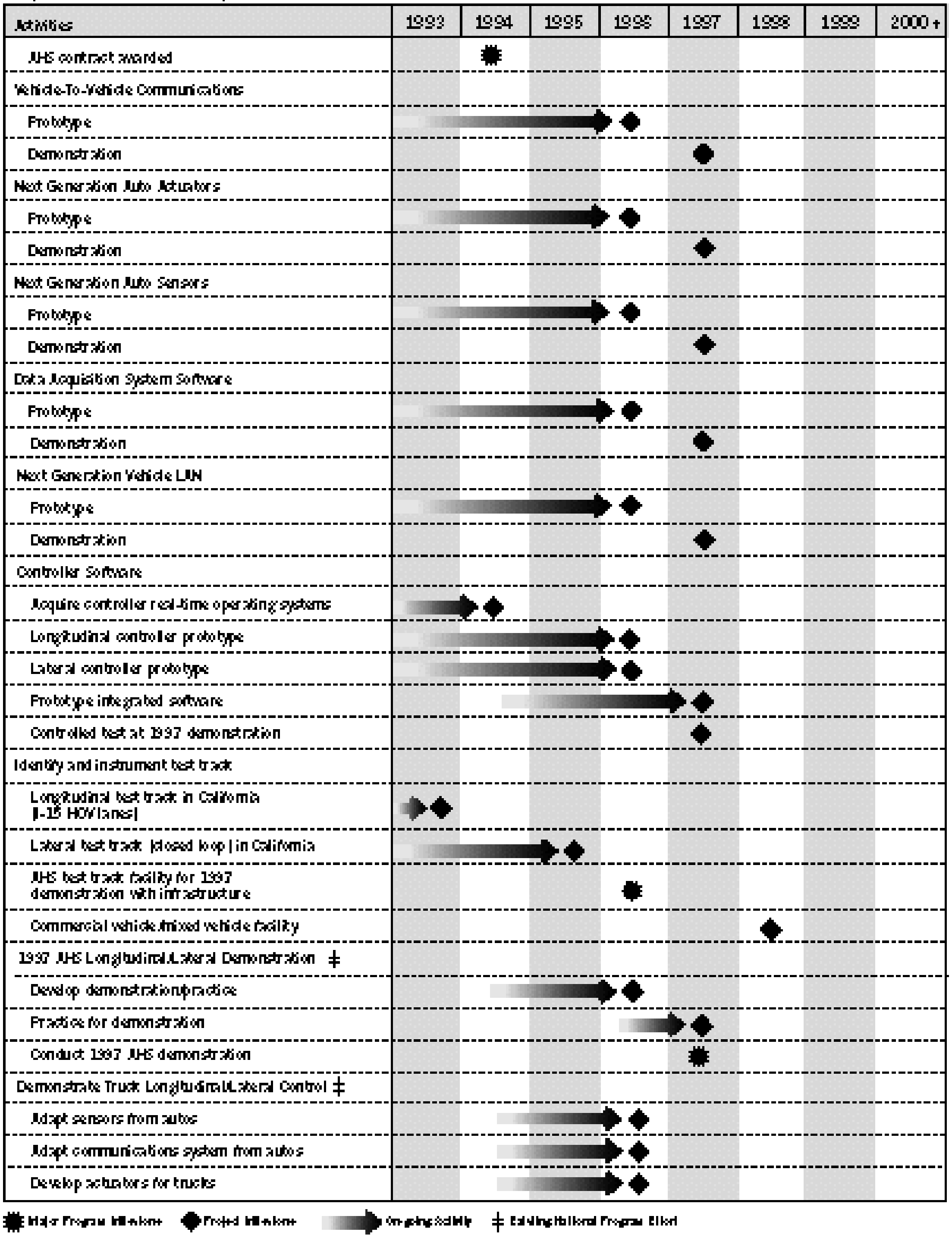
Pre-Crash Restraint Deployment



Advanced Vehicles

Smart Vehicles - Activity Charts

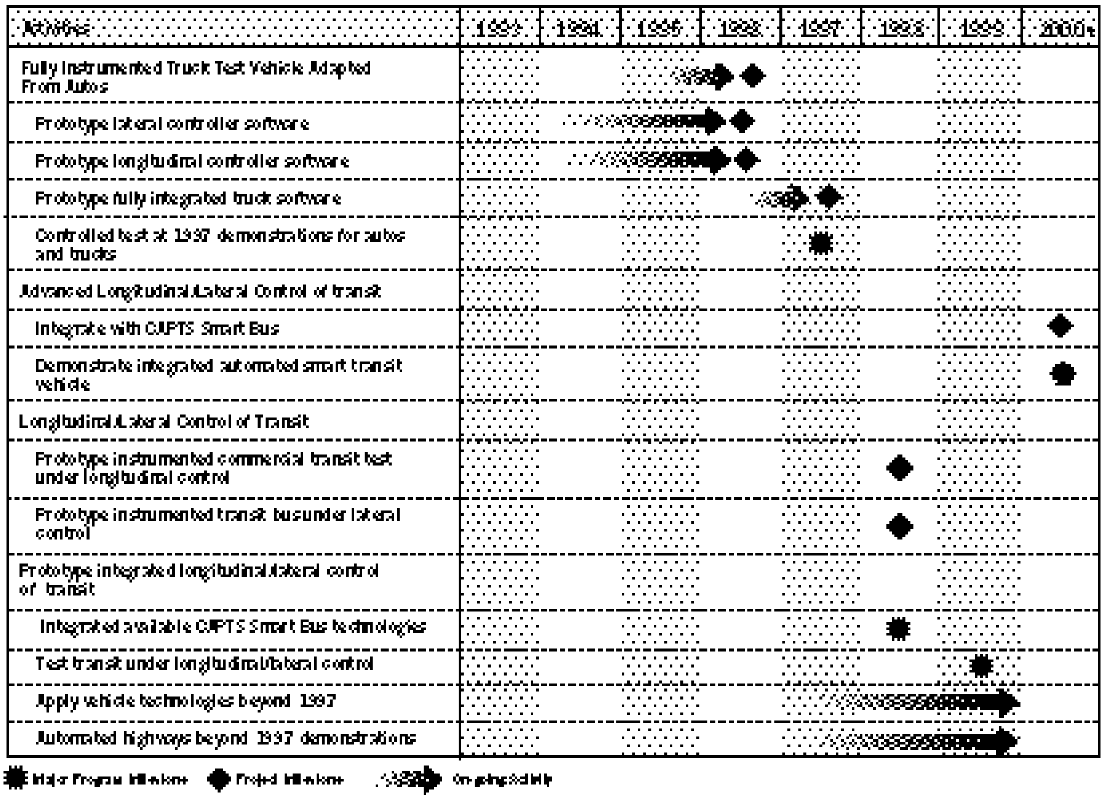
Fully Automated Vehicle Operations



Advanced Vehicles

Smart Vehicles - Activity Charts

Fully Automated Vehicle Operations contd



The Automated Highway System (AHS) Program

The ITS concept was developed to address the challenges of transportation system improvements which are required to meet the diverse needs of our mobile society. ISTEA (1991) Title VI, requires that "the Secretary of Transportation shall develop an automated highway and vehicle prototype from which fully automated intelligent vehicle highway systems can be developed. Such development shall include research in human factors to ensure the success of the man-machine relationship. The goal of this program is to have the first fully automated roadway or an automated test track in operation by 1997." The AHS development program is broadly structured into three phases:

- The Analysis phase;
- The Systems Definition phase; and
- The Operational Evaluation phase.

- **The analysis phase** was completed in November 1994, and the results were distributed to the interested stakeholder groups. This analysis phase will provide the analytical foundation for efforts to be conducted in the systems definition phase, which will include a human factors study analyzing key AHS requirements and issues; and, National Highway Traffic Safety Administration (NHTSA) sponsored collision avoidance-oriented vehicle warning and control services/devices which may evolve into an automated highway system.
- **The second, or systems definition phase** will identify system goals and identify, evaluate, and demonstrate selected AHS system concepts. Early products of this phase will be a Proof of Feasibility Demonstration in 1997 (mandated by ISTEA), a prototype demonstration in 2001, and a complete system specification and supporting documentation for the selected AHS configuration in 2002. The systems definition phase contract was awarded on October 7, 1994, to the National Automated Highway System Consortium (NAHSC) led by General Motors. The NAHSC consists of teams from Bechtel, Caltrans, Carnegie Mellon University, Delco Electronics, General Motors, Hughes Aircraft, Lockheed Martin, Parsons Brinckerhoff, the PATH Program, and the Mitre Corporation, which represents the Federal Highway Administration (FHWA). The seven-and-a-half year contract totals $200 million, with $160 million from FHWA and $40 million as cost sharing from the core participants. Funding is approved by Congress on a year-by-year basis.
- **The third, or operational evaluation phase**, will operationally evaluate one or more AHS implementations, with public participation. To be successful, the AHS must address and adequately resolve such issues as surface street capacity and gridlock. Simply adding a new source of vehicles to already overcrowded urban areas is not an acceptable alternative. Consortium teams are already working to include such items as full coordination with local and regional traffic management and planning agencies to insure these problems are dealt with in a satisfactory manner. The ultimate solution will include full coordination of all traffic management strategies.

Caltrans is actively working in partnership with other state and federal organizations, academia and private industry to research and develop advanced technologies that will be applied and demonstrated on an AHS.

Advanced Vehicles

Smart Vehicles - Project Highlights

Caltrans is fully committed to the AHS Program and anticipates active involvement in all three phases.

As a core member of the NAHSC, Caltrans has the unique privilege of representing the state and local highway operators stakeholder group. Additionally, Caltrans has the lead role for the consortium's test and demonstration activities. To support this role, Caltrans has one full-time system engineer in the NAHSC Program Office as the Test and Demonstration Coordinator. This engineer directs all activities related to testing of vehicles and technologies, the selection of all test facilities, and the planning and execution of the 1997 Proof of Feasibility Demonstration.

Caltrans participation in the NAHSC includes ten full-time staff engineers working on the various teams and tasks. The test and demonstration team is working to develop the I-15 reversible HOV lanes in San Diego as the site for the 1997 demonstration. Caltrans is the lead partner for this activity and heads all tasks related to tests and demonstrations, both from the New Technology and Research Program and from the NAHSC Program Office. Bringing the 1997 demonstration to California will provide an ideal "real world" facility for this demonstration, not just a closed loop "test track." Using this facility will allow for needed testing of advanced lateral and longitudinal control in a real world environment, and will accommodate ongoing testing as the state of the art develops.

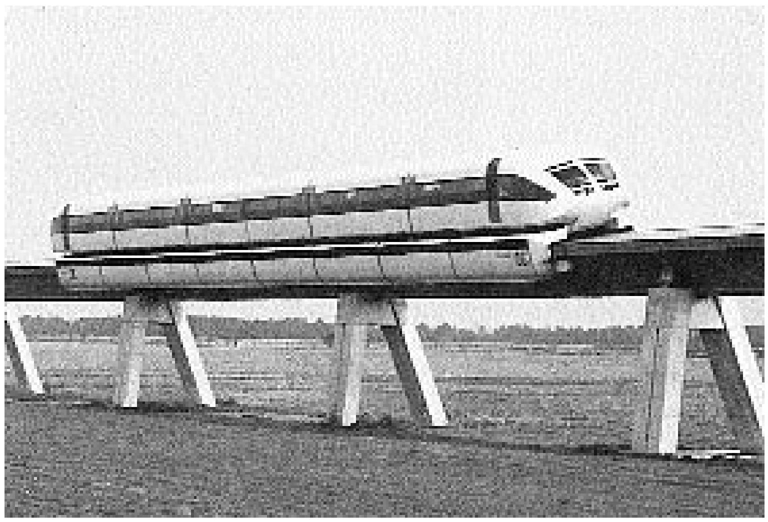
Caltrans also has major roles on the System Engineering; Canvassing and Outreach; Societal and Institutional Issues; Technology Assessment; Concept Development, and Business teams. Caltrans involvement on the Societal and Institutional issues team is particularly critical to insure proper assessment and development of the plans to address legal, environmental, land use, growth, and traffic management issues.

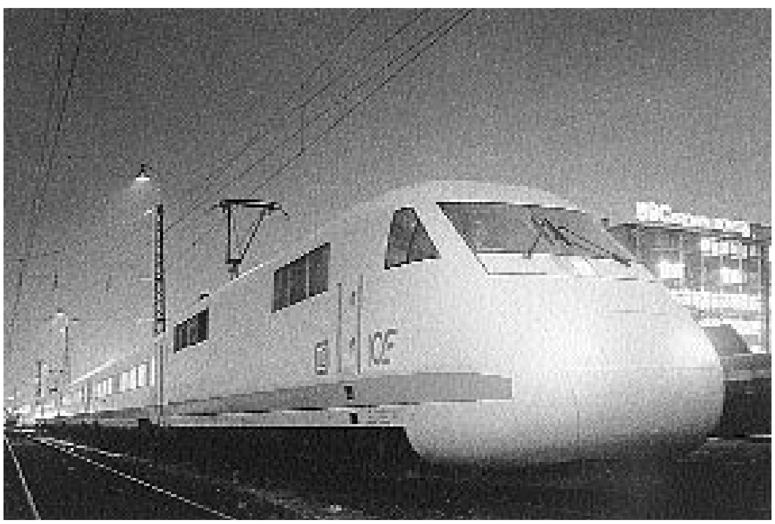
In addition to the full-time staff personnel in the New Technology and Research Program, Caltrans is drawing upon expertise from Traffic Operations, Central Design, and District 11 to perform various tasks. Of particular importance are the Caltrans District 11 personnel directly involved in the day-to-day operation of the I-15 HOV facility.

High-Speed Ground

The California passenger rail situation poses a unique challenge for locomotive and system designers. The general topography of the state consists of a series of valleys ringed by mountainous terrain. While high speed is needed, because intercity distances are great, especially along the San Francisco-Los Angeles line, the locomotive must also be able to climb. The Tehachapi "grapevine" section north of Los Angeles poses a challenge to any high/super-speed ground system. To avoid costly tunnels or time-consuming route circuity, it is preferable that the locomotive developed could climb five percent, or possibly greater, grades.

Existing high-speed rail systems are capable of traversing five percent grades with minor modifications to existing power units, but climbing grades in excess of five percent would require development of new kinds of locomotives and/or related systems. By conducting research and development, there is a good possibility that California products could be used. The recommended processes would result in creating new California High-Speed Ground Transportation (HSGT) suppliers while generating many blue- and white-collar high tech job opportunities. Once tested and proven, California-built equipment could be operating on selected California high-speed ground transportation corridors, as well as in corridors nationwide and internationally.





Advanced Vehicles

Alternative Vehicles - Scope

Air Transportation

Air transportation is another element of the ATS Program. The need for improvements in the air transportation systems in California and elsewhere is widely recognized. Deregulation has resulted in many changes in the transportation system, including shifts in traffic between modes, changing patterns of service, and increased dominance by major carriers. Many transportation problems and challenges are evident, such as deteriorating and inefficient ground access, inadequate system capacity, increasing congestion, international competition, lack of public and private sector response to problems, environmental impacts, dependence on imported fuels, economic opportunity losses, and a lack of an overall systems analysis approach. While at the same time, these changes and the need to respond to the growing problems create opportunities for technological innovation.

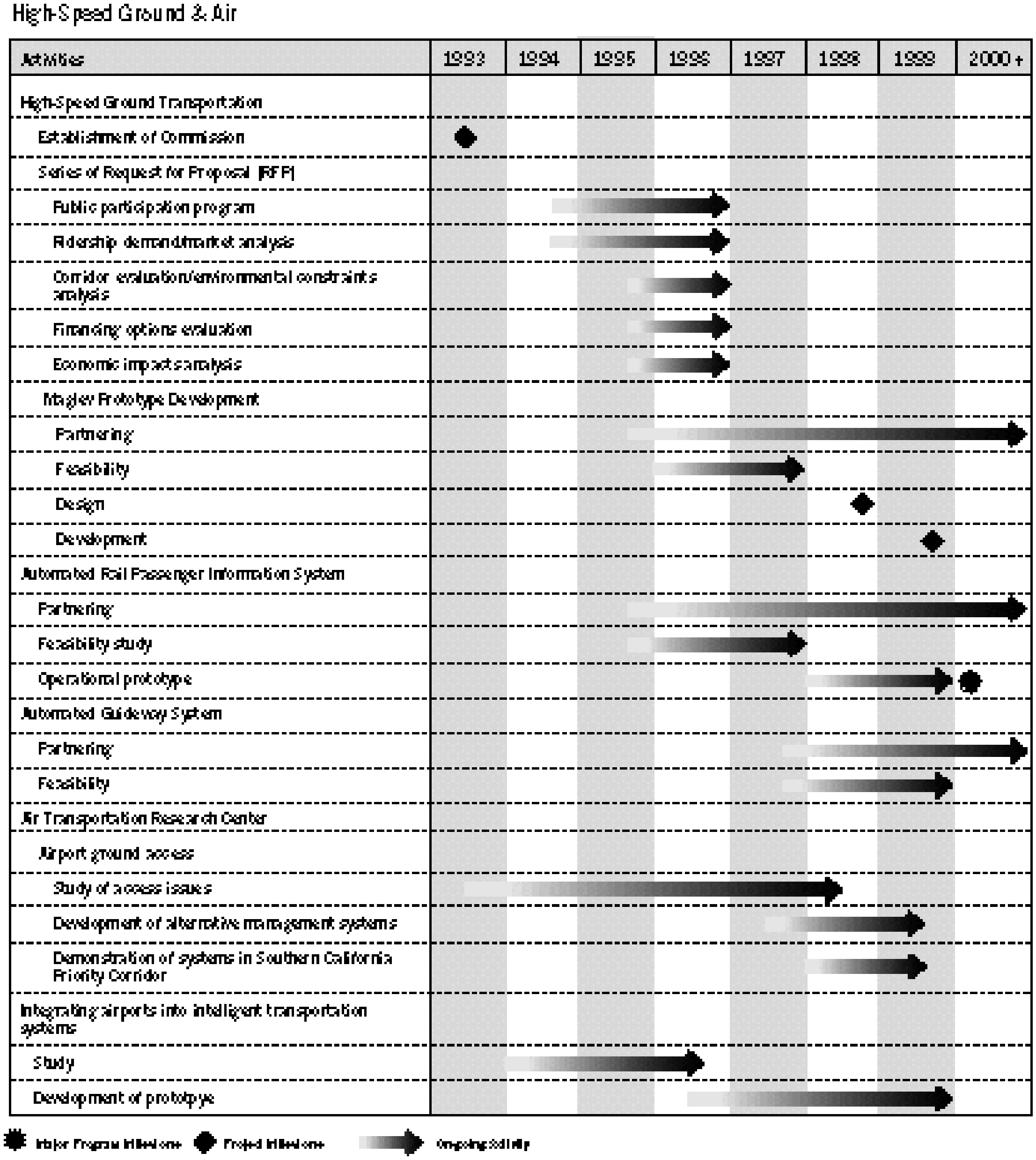
To effectively utilize new developments and respond to future opportunities, the ATS Program established a collaborative Air Transportation Research Center (ATRC) at the University of California's Institute for Transportation Studies, at Berkeley. The combined strengths of Caltrans and the university permit a coordinated systems approach to air transportation problems. The ATRC is a cooperative activity to enhance Caltrans' role in aviation and the mitigation of aviation related congestion. An additional purpose of the ATRC is to bring together partners to leverage private and public funds. The ATRC has addressed complex air transportation issues needed to make decisions, such as improving the management of ground access and intermodal transfers, increasing passenger and freight air travel, improving air quality, and facilitating economic development.

As the air transportation system continues to change, the ATRC agenda changes with it. Growth in air traffic is leading to increasing levels of congestion and delay. Extensive efforts are also being made on the land side of airport operations to utilize new communication and information technologies that will assist travelers, as well as managers of the airport facilities.

New aircraft types and concepts are being proposed, and extensive efforts are being made to increase the levels of automation in the air traffic control system and utilize new sensor, guidance, and communication technologies. Effective utilization of these new developments and those to come will provide Caltrans an opportunity to expand its research and development role in air transportation while working cooperatively with the Federal Aviation Administration, and NASA-Ames.

Advanced Vehicles

Alternative Vehicles - Activity Charts

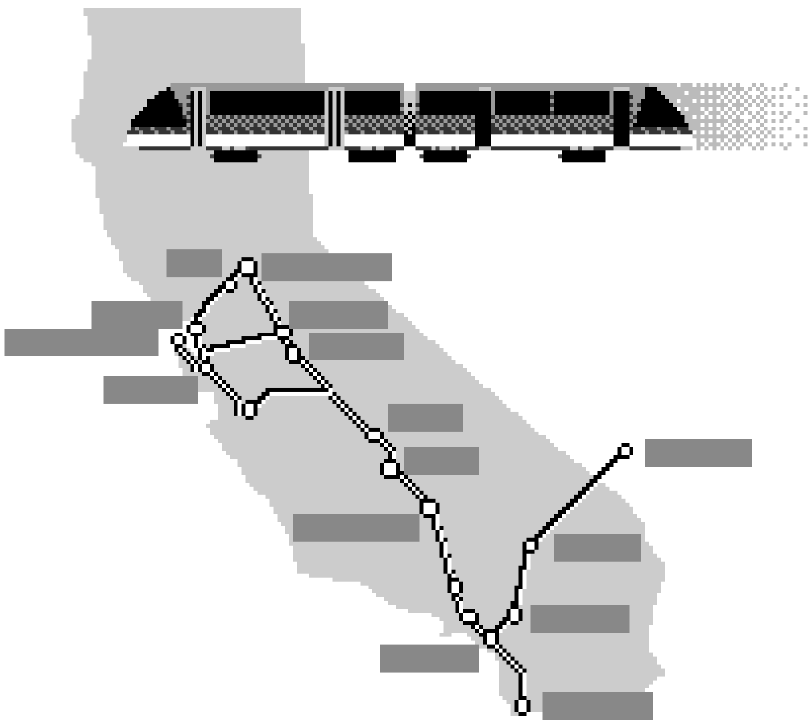


Advanced Vehicles

Alternative Vehicles - Project Highlights

California High-Speed Ground Transportation

On March 30, 1993, Governor Pete Wilson issued Executive Order W-48-93 establishing an Intercity High-Speed Ground Transportation (HSGT) Task Force. Subsequent to the Governor's Executive Order, the Legislature approved SCR (Senate Concurrent Resolution) 6 (Resolution Chapter 56/93) requesting the Governor to establish a nine-member Intercity High-Speed Ground Transportation Commission. SCR 6 requests that Caltrans, under the direction of the High-Speed Ground Transportation Commission, develop a 20-year high-speed ground transportation plan. SCR 6 also states that by year 2020 a high-speed ground transportation service should be operating between Sacramento, the San Francisco Bay Area, the Los Angeles area, San Bernardino/Riverside, Orange County and San Diego. SCR 6 stipulates that the Los Angeles to San Francisco Bay Area Corridor shall be the first corridor developed and that construction shall begin by 2000.



The department is working to develop the most feasible and effective plan for implementing HSGT in California. In concert with the Governor's Executive Order and SCR 6, Caltrans selected the Los Angeles to San Francisco Bay Area Corridor, with future expansions to San Diego, Orange County, Sacramento and Riverside/San Bernardino (Corridor) as its primary focus. This corridor is one of the most heavily traveled corridors in the United States; is considered one of the most viable candidates for a HSGT system; and has been designated as one of the five high-speed rail corridors in the United States by USDOT.

ISTEA legislation defined research agendas for both high-speed rail and maglev in an attempt to solve intercity transportation problems and to develop America's capability to supply products for possible corridors. Federal funding was also made available for selected high potential high-speed corridors. The San Diego-San Francisco Corridor was identified as one of five to start the incremental upgrade of existing rail routes to provide for safe high-speed rail grade crossings.

Since ISTEA was enacted into law, the federal government has appropriated less funding than authorized for the high-speed rail and maglev programs. The administration, however, is proposing to create a transportation infrastructure investment program that would include $1 billion in discretionary funds that states could use for high-speed rail. USDOT is also recommending an additional $35 million for high-speed rail research and development for fiscal year 1995-96 under the Next Generation High-Speed Rail Program.

Against this background, the California Intercity High-Speed Rail Commission continues to examine the feasibility of a high speed rail system (including the option of maglev) in California. As part of its examination, the Commission has authorized the preparation of four important studies.

They are:

- Corridor Evaluation and Environmental Constraints Analysis
- Ridership Demand/Market Analysis
- Economic Impacts Analysis and Mode Cost Comparison
- Institutional Analysis and Financing Options Evaluation

The fourth study, Institutional Analysis and Financing Options will include insight into proposed federal funding of high-speed rail programs after 1997. In addition, it would include models for entering into successful public/private partnerships.

The final plan should be completed by the end of calendar year 1996.

TRANSPORTATION MANAGEMENT SYSTEMS

Multimodal Traffic Management

- *Incident Management*
- *Travel Demand Management*
- *Traffic Control*
- *Electronic Payment Services*
- *Public Travel Security*
- *Emergency Notifications and Personal Security*

Advanced Fleet Management

- *Automated Roadside Safety Inspection*
- *Public Transportation Management*
- *Commercial Fleet Management*
- *Commercial Vehicle Preclearance*
- *Commercial Vehicle Administrative Processes*
- *Emergency Vehicle Management*

Intermodal Facilities

Transportation Management Systems is a package of technologies that enables the integration of freeway and surface arterial operations so that travel corridors and areas can be efficiently managed and will enhance communications for commercial vehicle operations.

The milestones, scope of services, activities and specific project highlights for Transportation Management Systems are discussed on the following pages.

Transportation Management Systems

1993	1994	1995	1996	1997	1998
California Specification - AVI		Electronic Toll Collection Deployment	Advanced Transit Fleet Management Demonstration	Real-Time Adaptive Traffic Control Demonstration	Multimodal TMC Demonstration
		"Smart Corridor" Demonstration	National ITS System Architecture Selected	HOV Route Guidance Test	Public Travel Security Demonstration
		ATMS Test Bed Established	Prototype HOV - TMC Interaction	Emergency Notification (Mayday) Demonstration	
		H.E.L.P. Implementation	Guidelines for Navigable Map Database		
1993	1994	1995	1996	1997	1998

Transportation Management Systems

Multimodal Traffic Management — Scope

Transportation Management Systems - Multimodal applications can be defined in these user services terms:

- **Incident Management**

  Helps officials quickly identify incidents and implement a formalized set of procedures to minimize impacts on the transportation system.

Incident management will also help schedule or forecast predicted incidents to minimize impacts. Predicted incidents include road construction and maintenance, road closures, and certain severe weather conditions. Verification and response activities apply to both predicted and unpredicted incidents once they occur. Incident management will support the development and implementation of appropriate response actions including changing traffic control. In some cases, where incident management is closely integrated with other user services, automation will improve the speed and effectiveness of responses.

- **Travel Demand Management**

  Supports policies and regulations such as the 1990 Clean Air Act.

The act requires employers with over 100 employees in designated areas of severe or extreme ozone pollution to implement a travel demand management program. The concept includes:

- Reducing the number of single-occupancy vehicles commuting to work;
- Increasing the use of high-occupancy vehicles for selected user group markets;
- Mitigating the impact of highly polluting vehicles; and,
- Providing a wide array of mobility options.

Government and private industry can use travel demand management dynamically, depending on congestion and pollution conditions in a given area, at a given time. Applications include enforcing HOV lane use, parking control, and road access pricing and prioritization schemes.

- **Traffic Control**

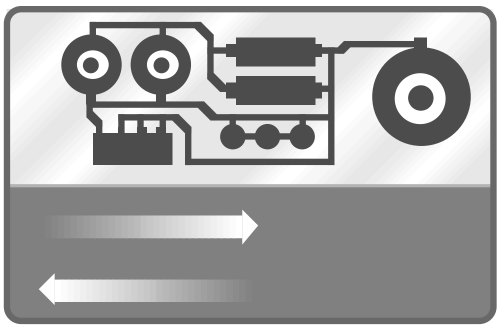
  Manages the movement of traffic on the transportation system.

Traffic control services optimize and coordinate freeway and signalized street operations with public transportation operations to balance demand with capacity within the transportation system. In its more advanced forms, preferred treatment can be given to high-occupancy vehicles through traffic signal and adaptive traffic control.

- ### Electronic Payment Services

Allows travelers to pay for transportation services with electronic cards or tags.

The goal is to provide travelers with a common electronic payment medium for all transportation modes and functions including tolls, transit fares, and parking. A common service fee and payment structure, employing multi-use SmartCards, could integrate all modes of transportation, including roadway pricing options.



- ### Emergency Notification and Personal Security

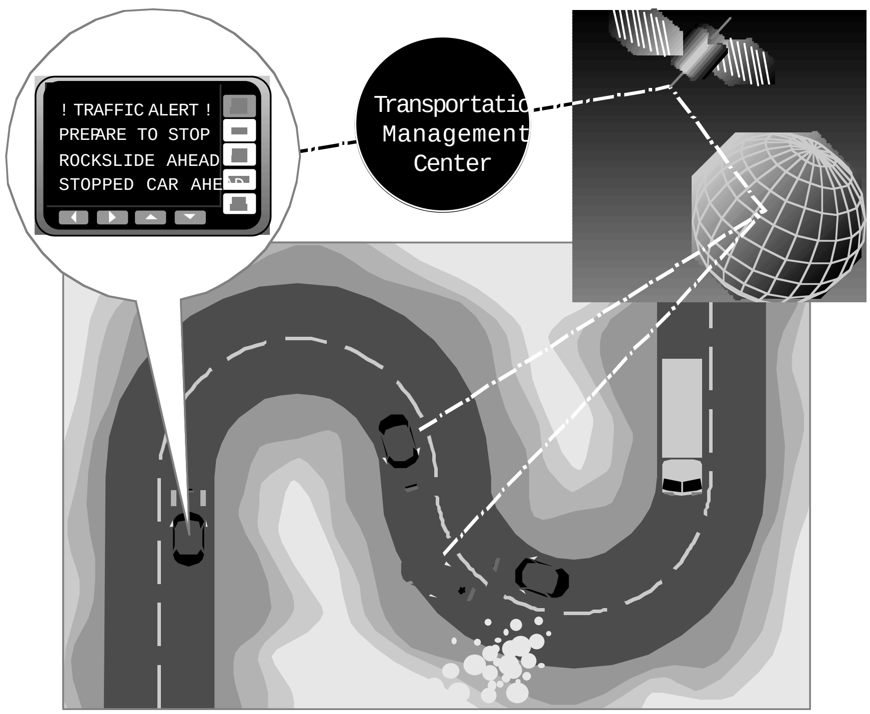
Provides immediate notification of an incident and immediate request for assistance.

Emergency notification and personal security includes two capabilities: driver/personal security, and automatic collision notification. Driver and personal security capabilities provide for user initiated distress signals for incidents like mechanical breakdowns and carjackings. The message will include vehicle location and the receiver will send an acknowledgment signal back to the user. Automatic collision notification identifies a collision and automatically sends information regarding location, nature, and severity to emergency personnel.

- ### Public Travel Security

Creates a secure environment for public transportation patrons and operators.

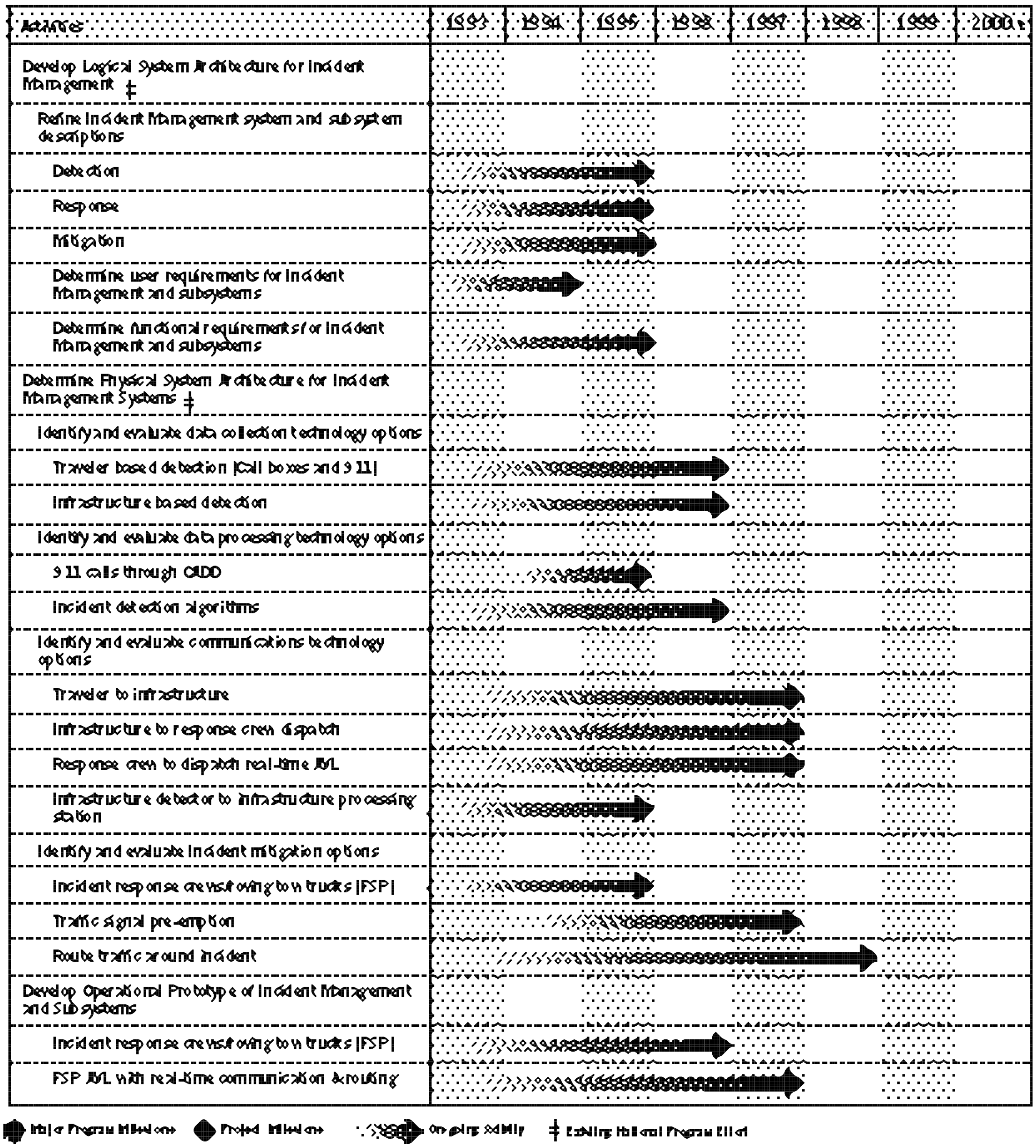
The automobile separates its passengers from the surrounding environment and provides a perception of security and personal control. Public transportation users must trust control of their environment to the operator and local police.



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

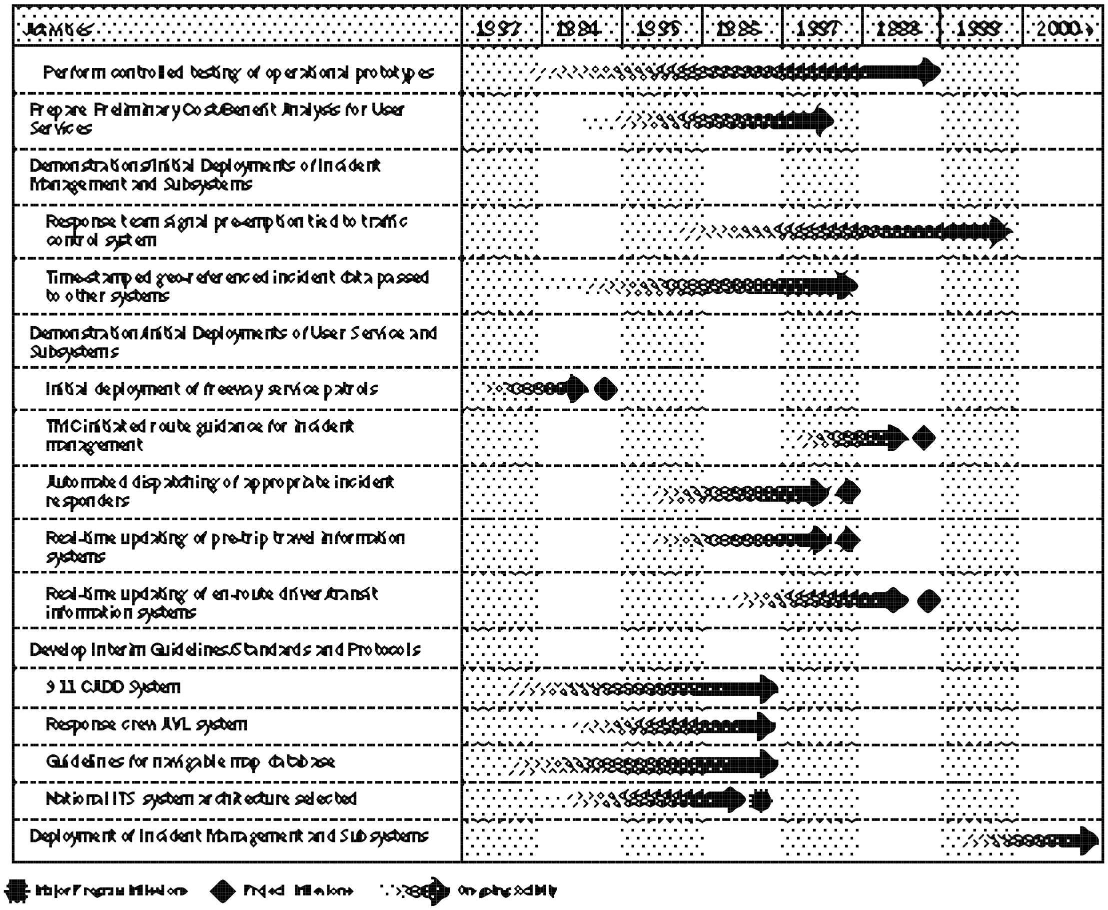
Incident Management



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

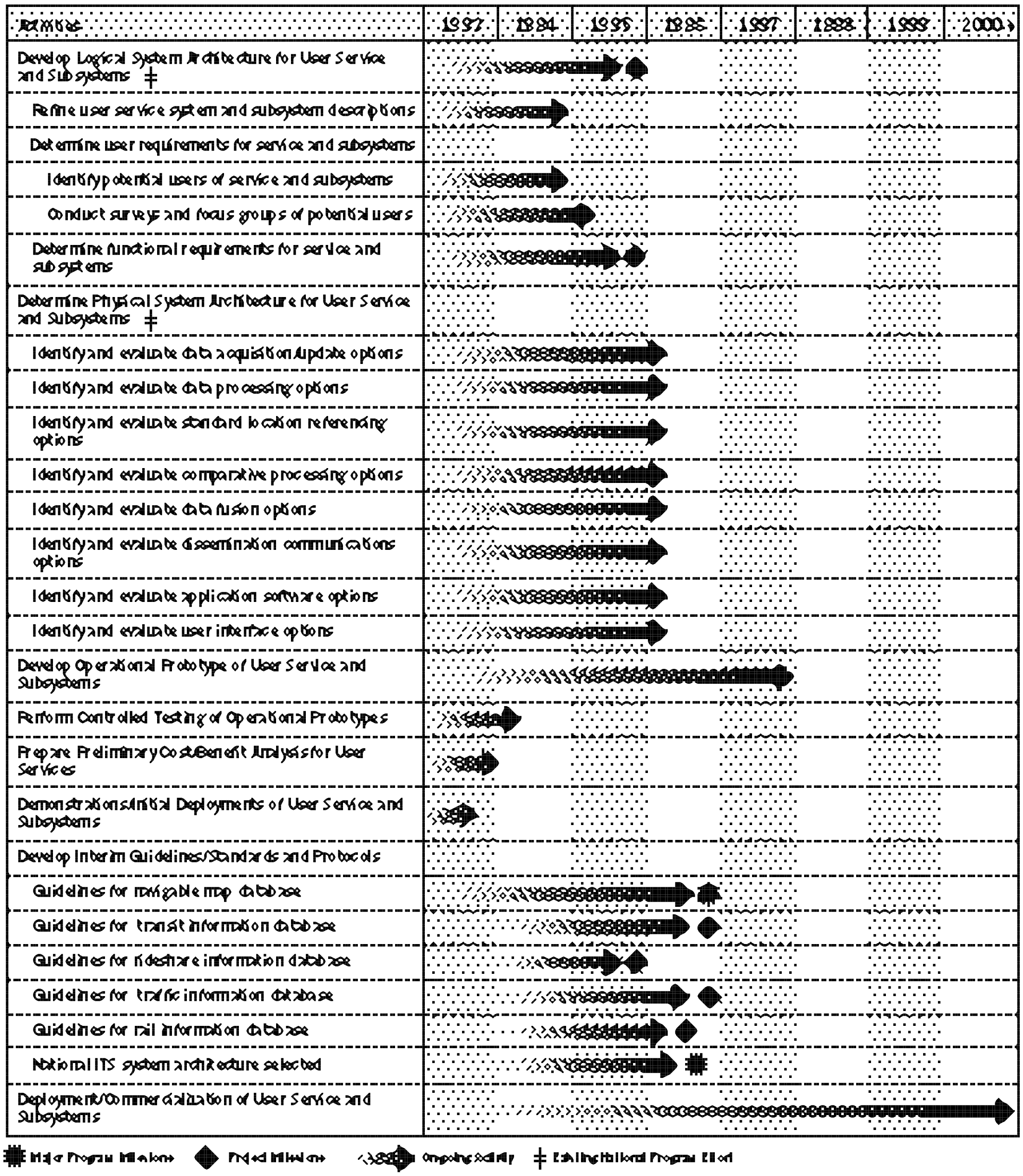
Incident Management contd



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

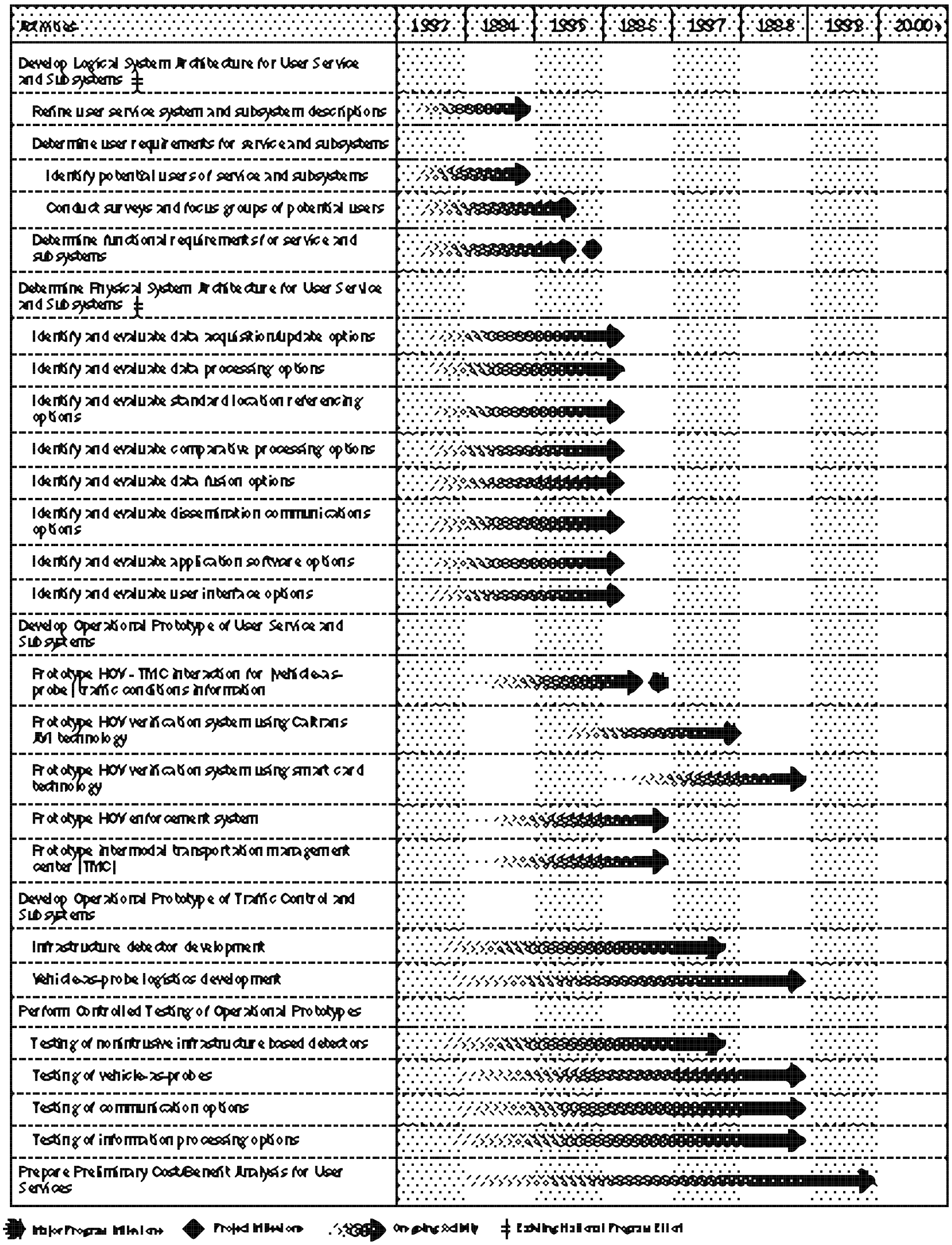
Travel Demand Management



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

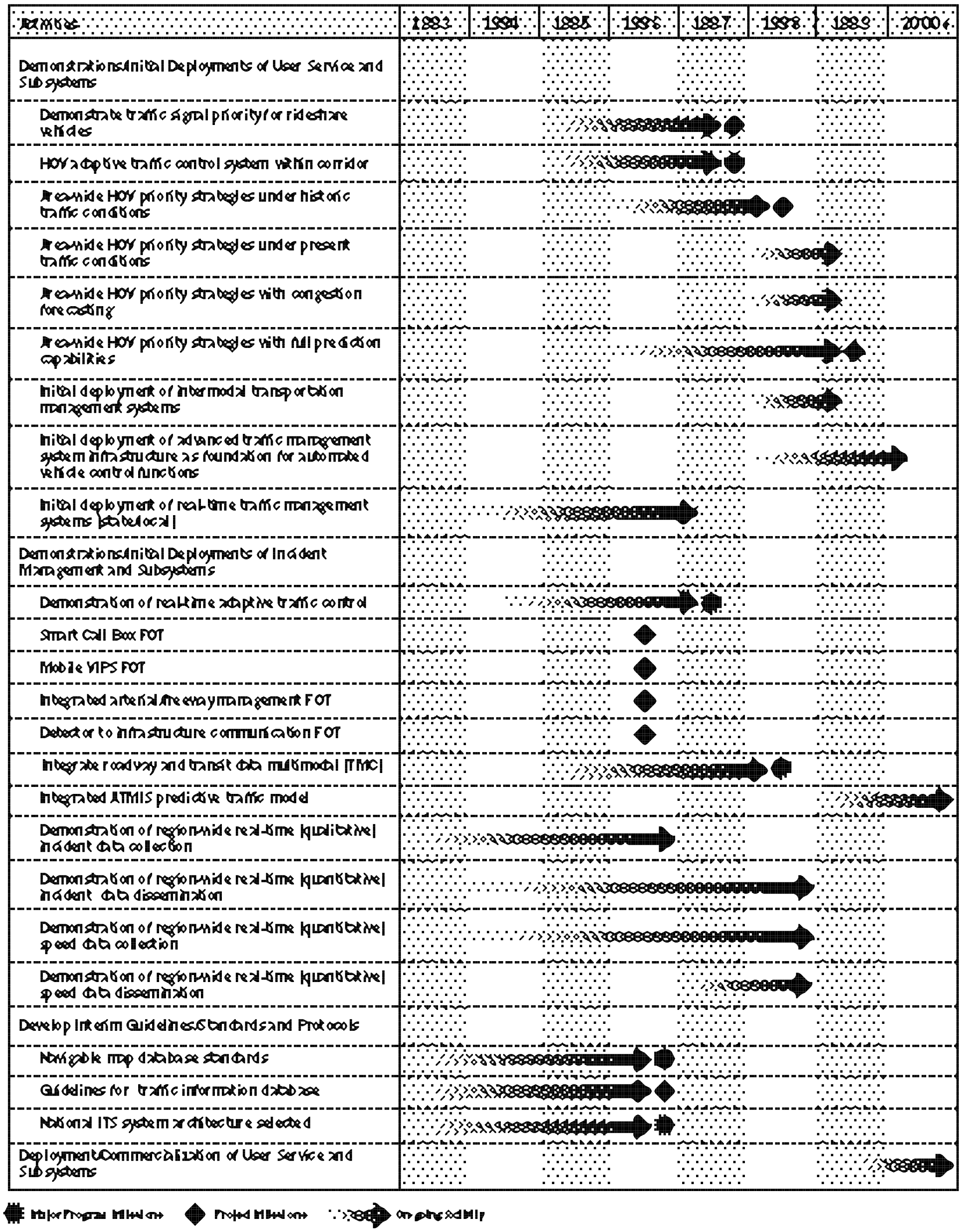
Traffic Control



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

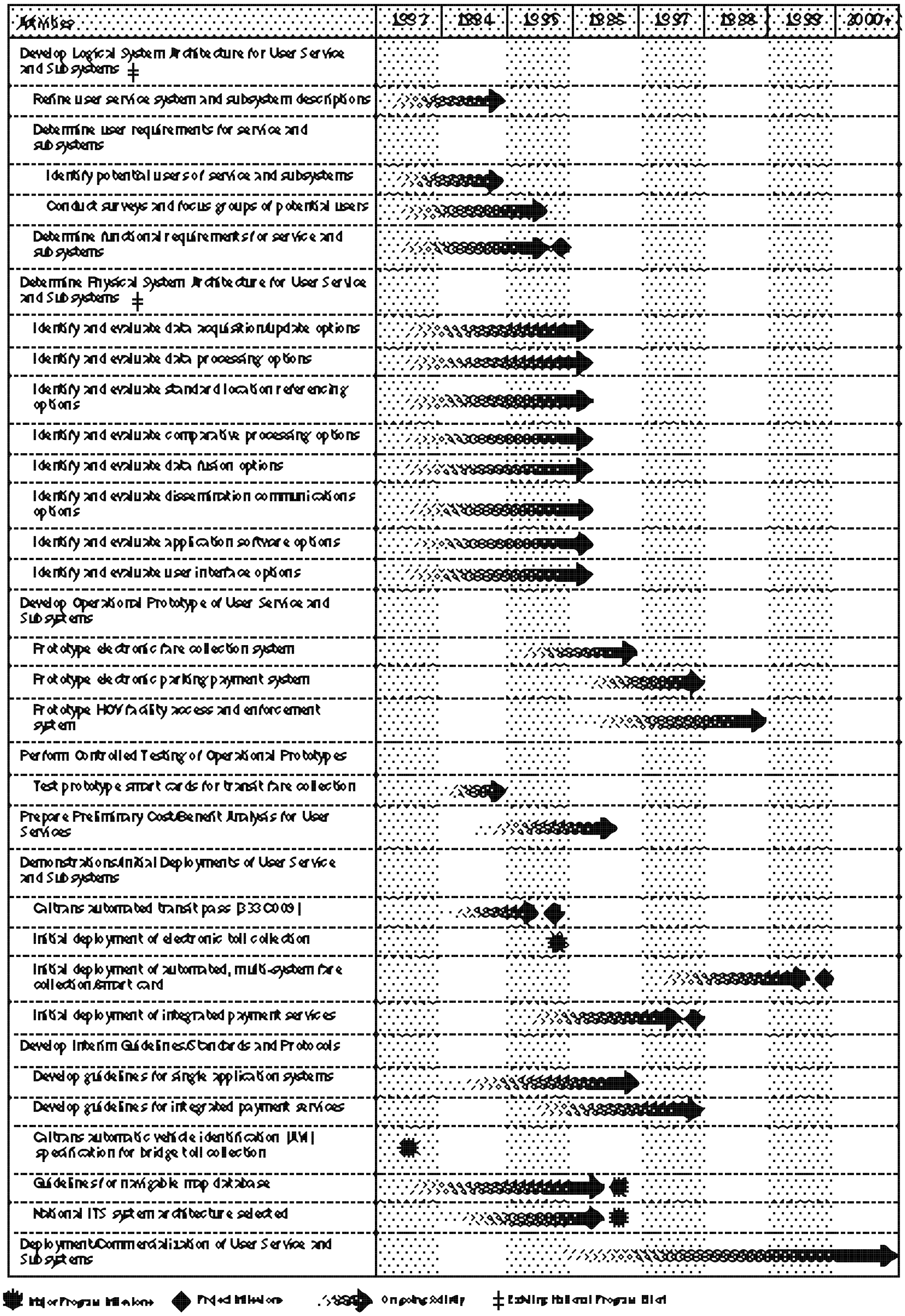
Traffic Control cont'd



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

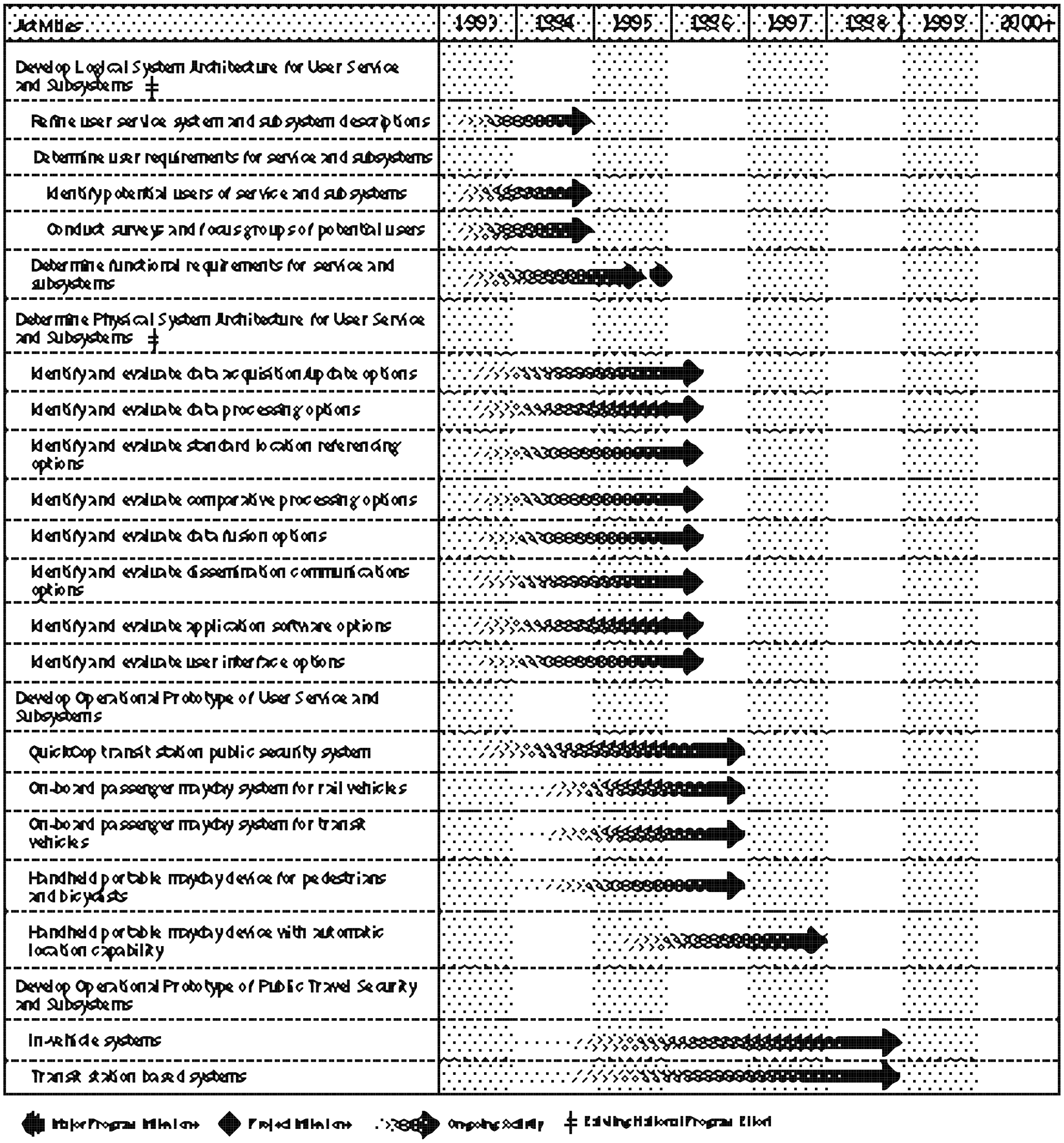
Electronic Payment



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

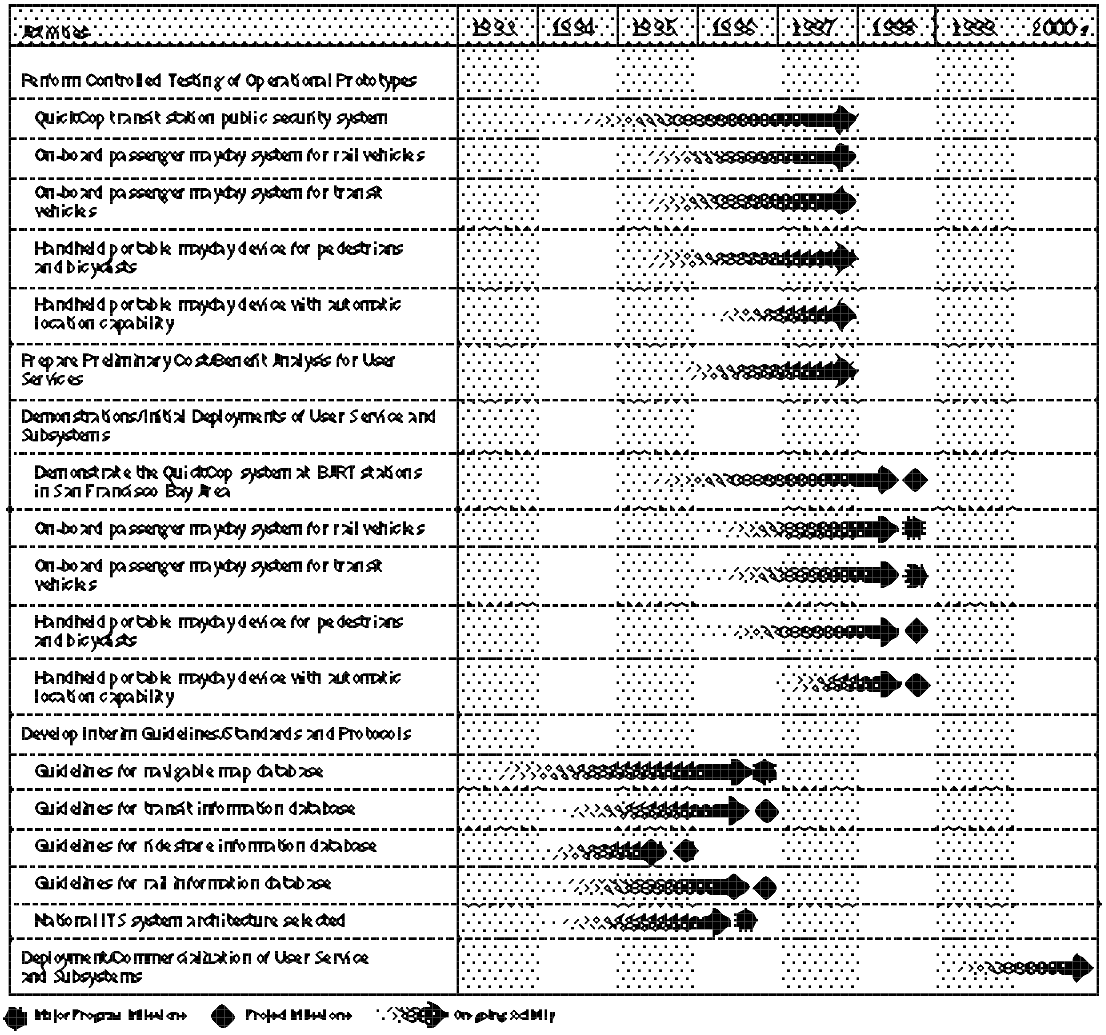
Public Travel Security



Transportation Management Systems

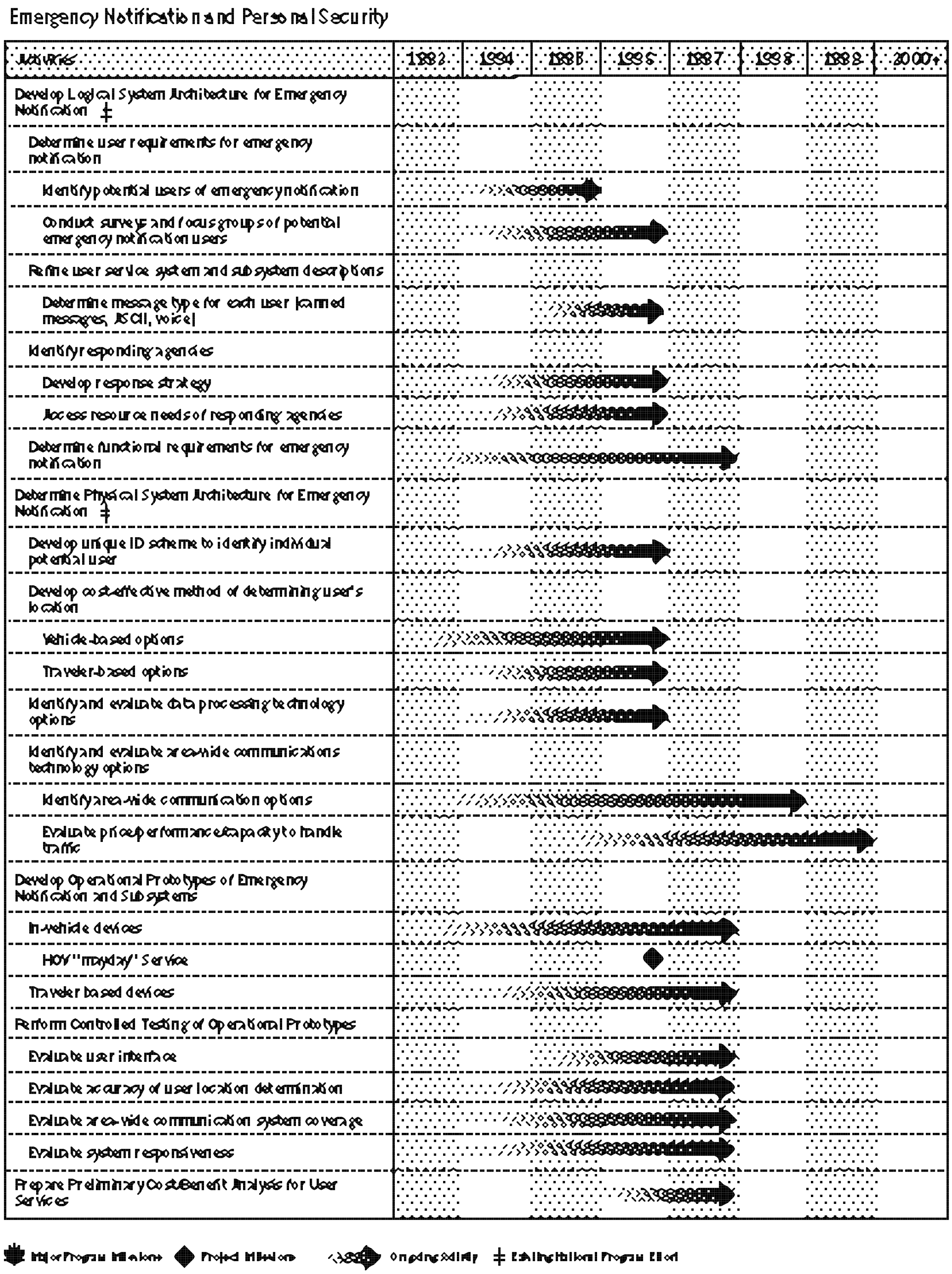
Multimodal Traffic Management — Activity Charts

Public Travel Security contd



Transportation Management Systems

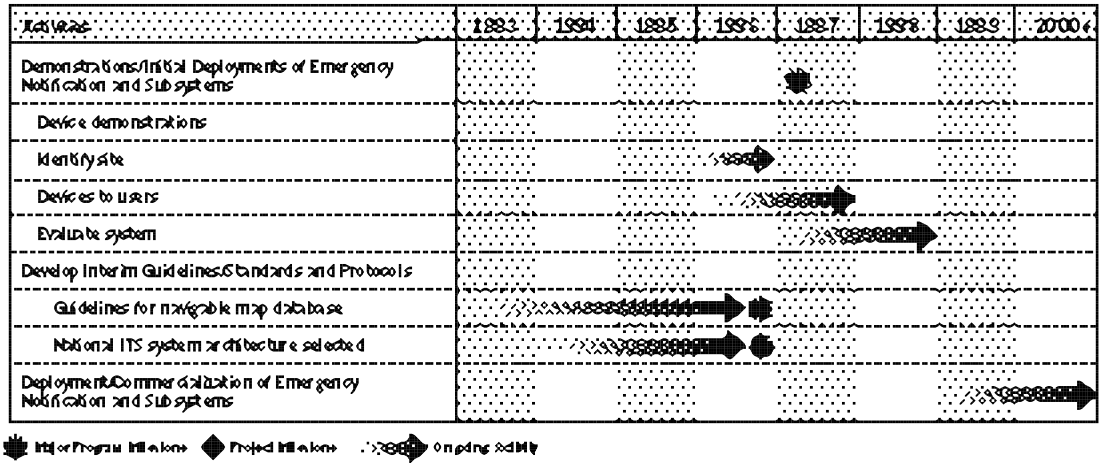
Multimodal Traffic Management — Activity Charts



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

Emergency Notification and Personal Security contd



Transportation Management Systems

Multimodal Traffic Management — Project Highlights

Transportation Management Systems/Centers

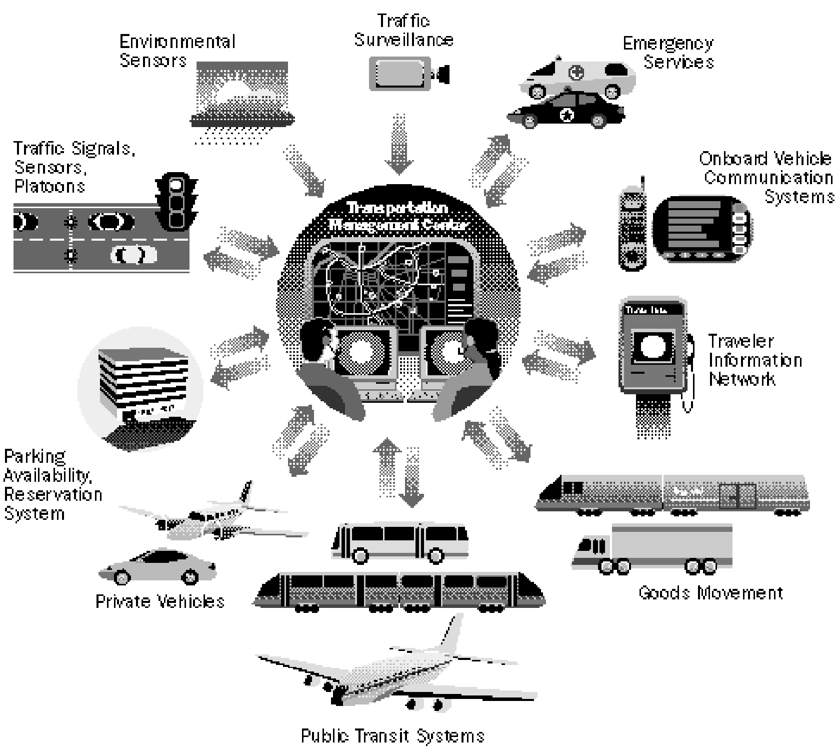
For the past 20 years, Caltrans has been utilizing state-of-the-art technology to manage over 750 miles of southern California freeways. Ramp metering, now commonplace in many areas of the state, was first implemented in southern California in 1970. Plans, which included a Traffic Operations Center (TOC), for traffic mitigation for the 1984 Olympics, were developed starting in 1976 and made history in the field of traffic management. The importance of traffic surveillance in managing traffic was clearly demonstrated during this monumental undertaking.

A Transportation Management Center (TMC) simulator is in place at California Polytechnic State University, in San Luis Obispo

The Los Angeles TOC, the first in the state, is still its most advanced and has become a blueprint for those being developed in major metropolitan areas throughout California. Formerly TOCs, they are now called Transportation Management Centers (TMCs) because they encompass so much more than just traffic operations. TMCs are jointly developed and staffed by the California Highway Patrol and Caltrans—the first partnership of its kind in the country.

The next logical step in this progression is the development of an Intermodal Transportation Management and Information System (ITMIS) (see page 192). An ITMIS is a building block for the transportation system. There are two major approaches for its design. In Orange County (Caltrans District 12), efforts are focused on developing a distributed system of centers linked by communications and data. The new TMC in San Diego (opened in July 1995) includes the California Highway Patrol and Caltrans Maintenance and Operations Communications Center all in one location. In the future, the center will include transit and commercial fleet operators and other local transportation providers.

Caltrans has already established a TMC simulator at California Polytechnic State University in San Luis Obispo to help train traffic managers and TMC operators in optimal TMS strategies. Computer-based expert systems will also help TMC operators handle accidents, hazardous material spills and other incidents and emergencies, and would enable automation of routing management functions now performed by humans. Fiber optics and satellite communications can provide the broad bandwidth necessary for video image and high volume data transmission from field to control center, and among control centers (state and local).



Advanced Fleet Management applications can be defined in the following user services terms:

- **Automated Roadside Safety Inspection**

  Focuses on improving safety in all commercial vehicle operations.

Automated roadside safety inspections include roadside access to records of carriers, vehicles, and driver safety. Such convenient and thorough access will be helpful in determining what should be checked and how to maximize resources spent on safety. Advanced diagnostics will efficiently check critical vehicle systems and driver fitness for duty.

These capabilities will provide safer, more efficient, and more accurate inspection of commercial vehicles. Enforcement personnel will have access to important safety information and records for all commercial vehicles. Automated inspections could provide pass/fail assessments of critical systems, as well as expected life projections. Carriers could also apply rapid automated safety checks in their preventive maintenance programs.

- **Public Transportation Management**

  Automates operations, planning, and management functions.

Computer analysis of real-time vehicle and facility status will improve operations and maintenance. The analysis identifies deviations from schedule and provides potential solutions to dispatchers and drivers. Integrating this capability with traffic control services can help maintain transportation schedules and assure transfer connections in intermodal transportation. Automated planning and scheduling capabilities will use archived data for analyzing trends. Information regarding passenger loading, bus running times, and mileage accumulated can be applied to route and service improvement. Automatically recording and verifying performed tasks will help with personnel management.

- **Commercial Fleet Management**

  Provides the same capabilities and performs the same functions in the commercial goods movement area as in public transportation management.

Technological advances in public transportation management are directly applicable to commercial vehicles providing goods movement. Caltrans is heavily involved in promoting advanced technologies that facilitate improved fleet operations. Currently, there is a research project to determine the most appropriate role for government in furthering fleet management services and their applications for improving intermodal transfers.

Caltrans and the CHP will continue development efforts in these areas and will collaborate with companies that transport goods in developing new transportation systems.

Transportation Management Systems

Advanced Fleet Management — Scope

- **Commercial Vehicle Preclearance**

  Facilitates domestic and international border preclearance, minimizing stops.

This user service provides for point to point non-stop operation while satisfying regulatory requirements such as the issuance of licenses and permits, record keeping, tax collections, and inspection and weighing across multiple jurisdictions, including domestic and international borders.

- **Commercial Vehicle Administrative Processes**

  Provides electronic purchasing of credentials and automated mileage and fuel reporting.

Electronically purchasing credentials gives carriers the option to select and purchase annual and temporary credentials via computer link with the appropriate jurisdictions. Automatic deductions from the carrier's account with a jurisdiction will also streamline processing. There is a potential for synergy with commercial vehicle preclearance services.

For registration and auditing purposes, carriers maintain accurate mileage and vehicle information for every trip. Automating this procedure with the commercial vehicle administrative processes service enables participating interstate carriers to electronically capture mileage, fuel purchase, trip, and vehicle data by state. Electronic logs eliminate the need to manually prepare quarterly reports for fuel taxes and annual reports for registration.

- **Emergency Vehicle Management**

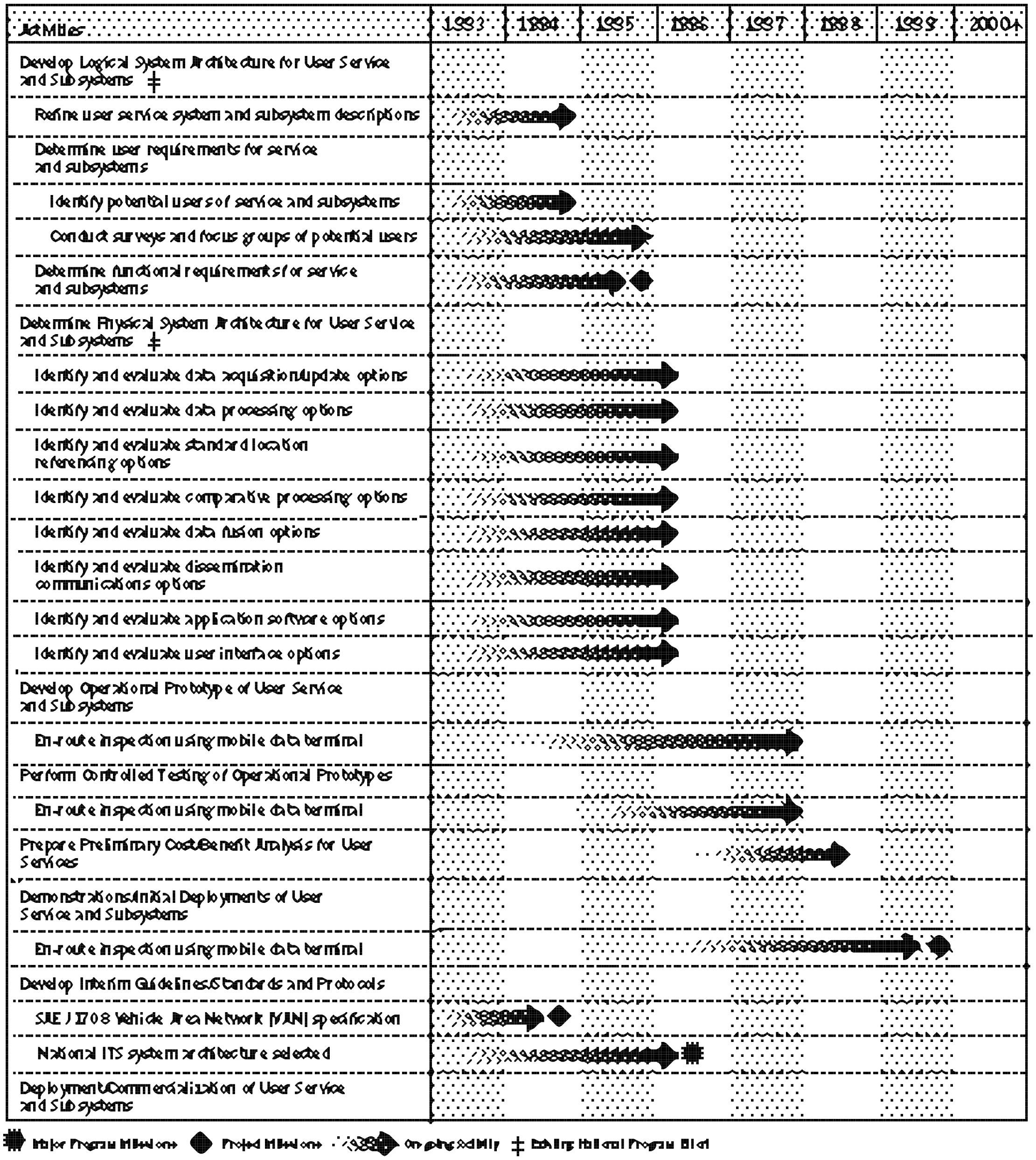
  Reduces the time it takes to respond to incident notification and arrive on the scene.

This user service is closely related to the hazardous material incident management user service, within the commercial vehicle operations category. Primary users include police, fire and medical units. The service comprises three capabilities: fleet management, route guidance, and signal priority. Fleet management will improve the display of emergency vehicle locations and help dispatchers efficiently send the unit that can most quickly reach an incident site. Route guidance directs emergency vehicles; signal priority clears traffic signals on an emergency vehicle's route.

Transportation Management Systems

Advanced Fleet Management — Activity Charts

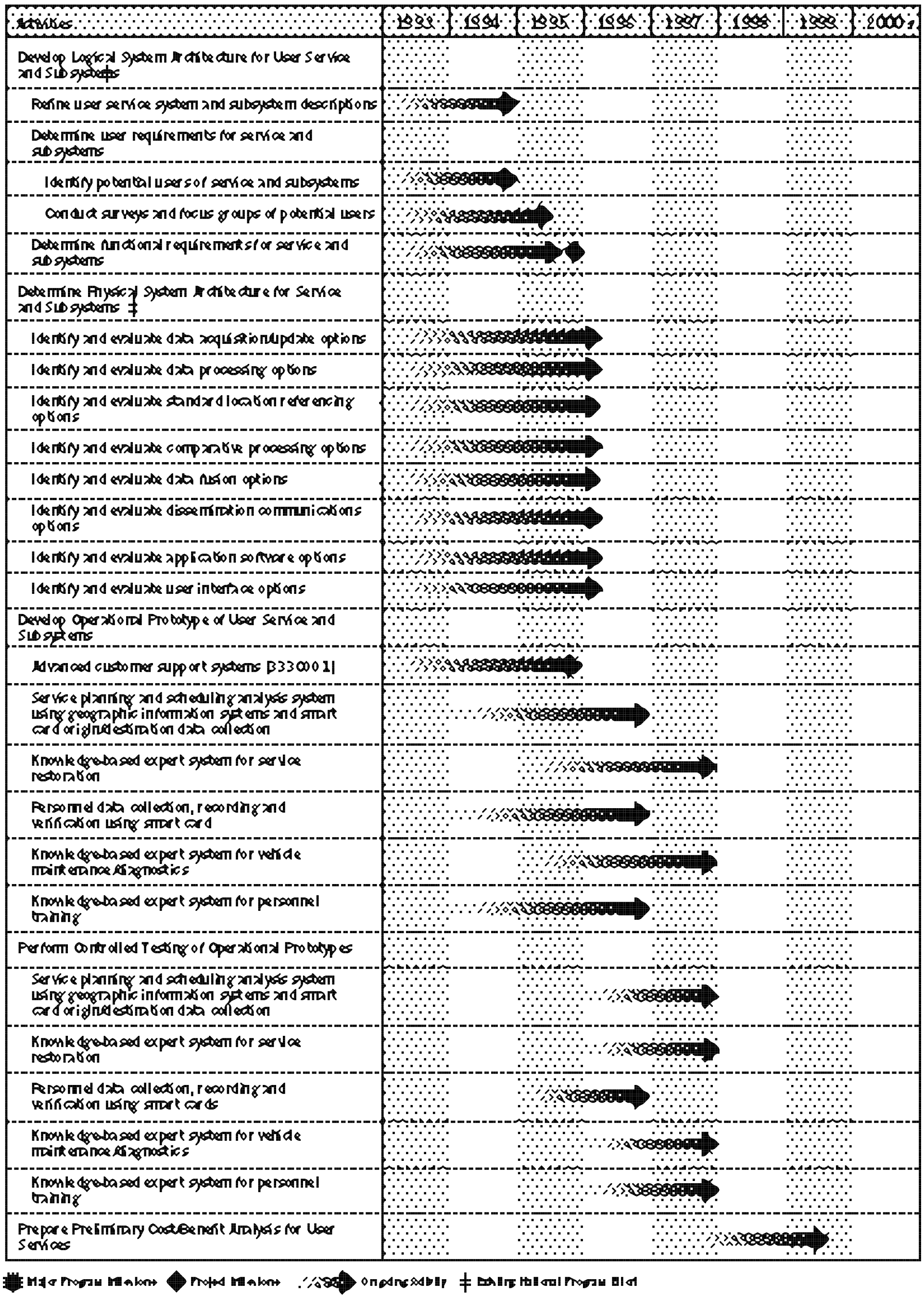
Automated Roadside Safety Inspection



Transportation Management Systems

Advanced Fleet Management — Activity Charts

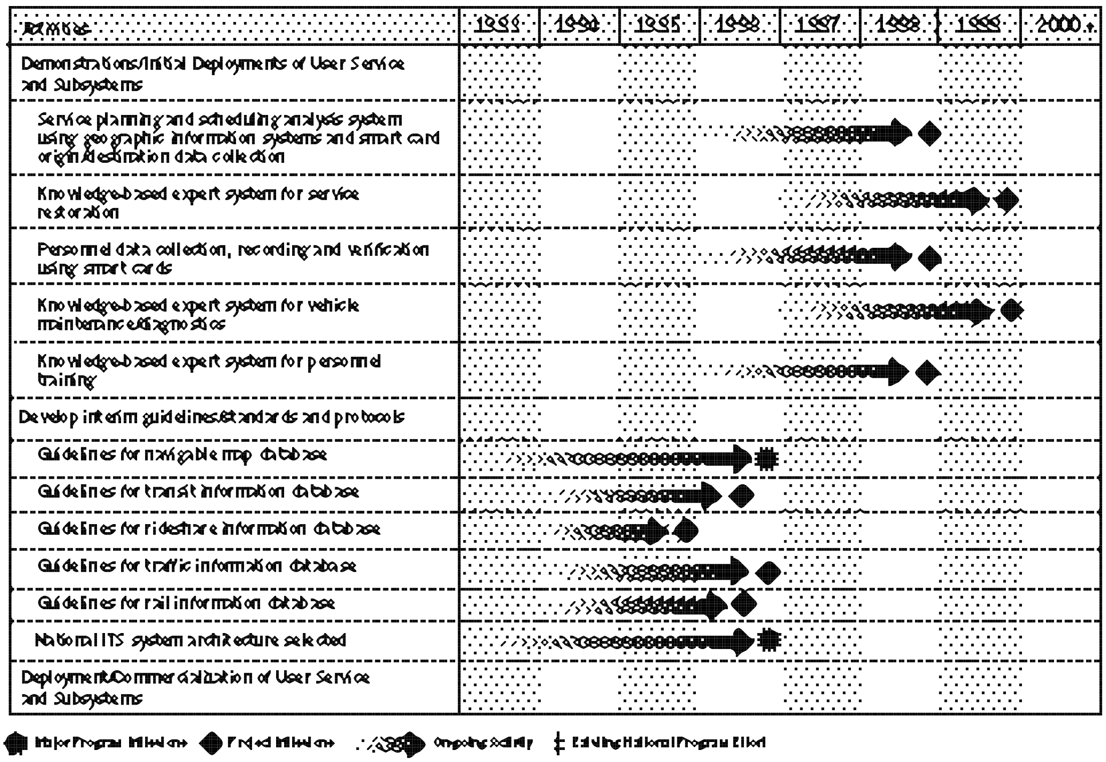
Public Transportation Management



Transportation Management Systems

Advanced Fleet Management — Activity Charts

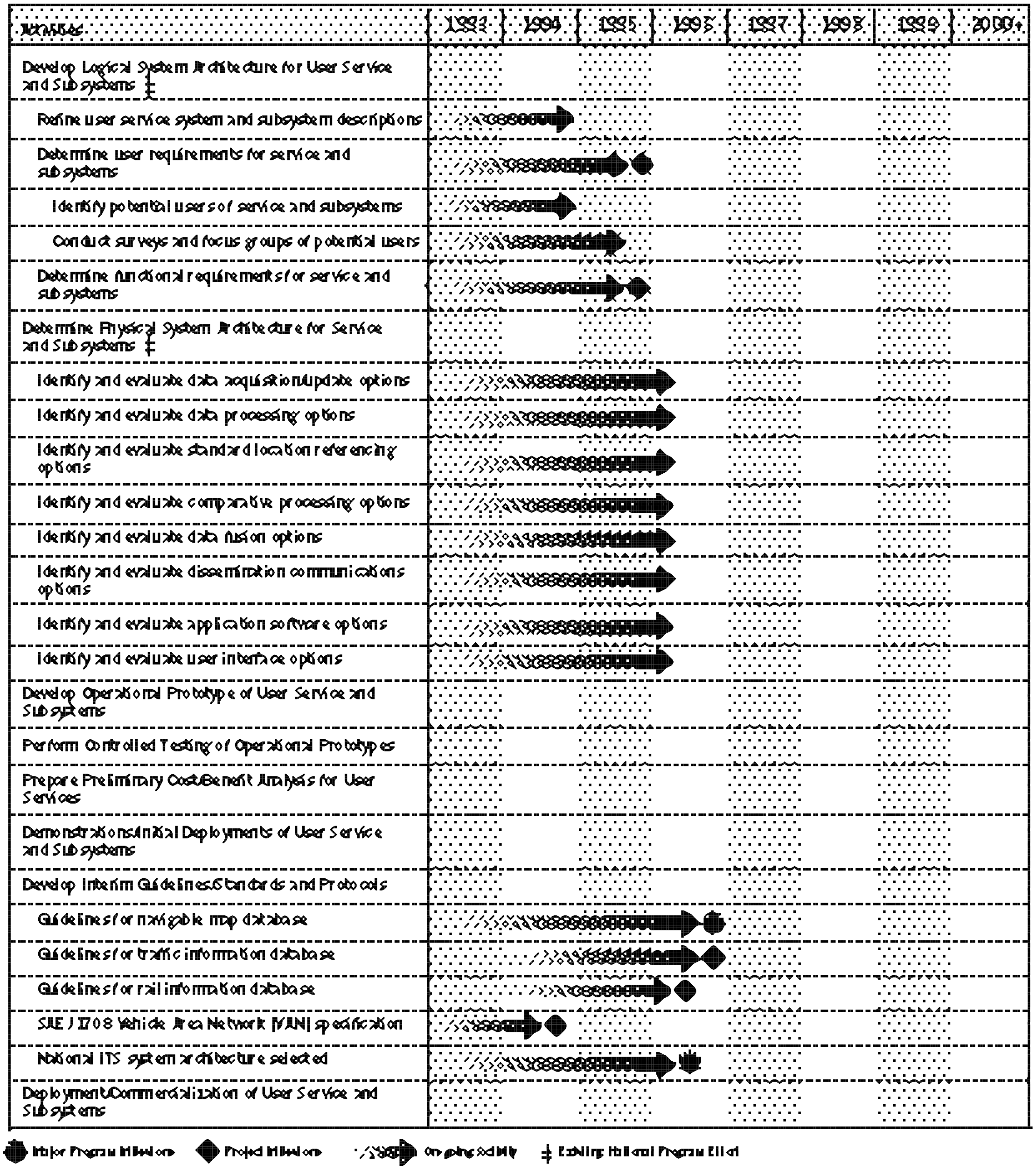
Public Transportation Management cont'd



Transportation Management Systems

Advanced Fleet Management — Activity Charts

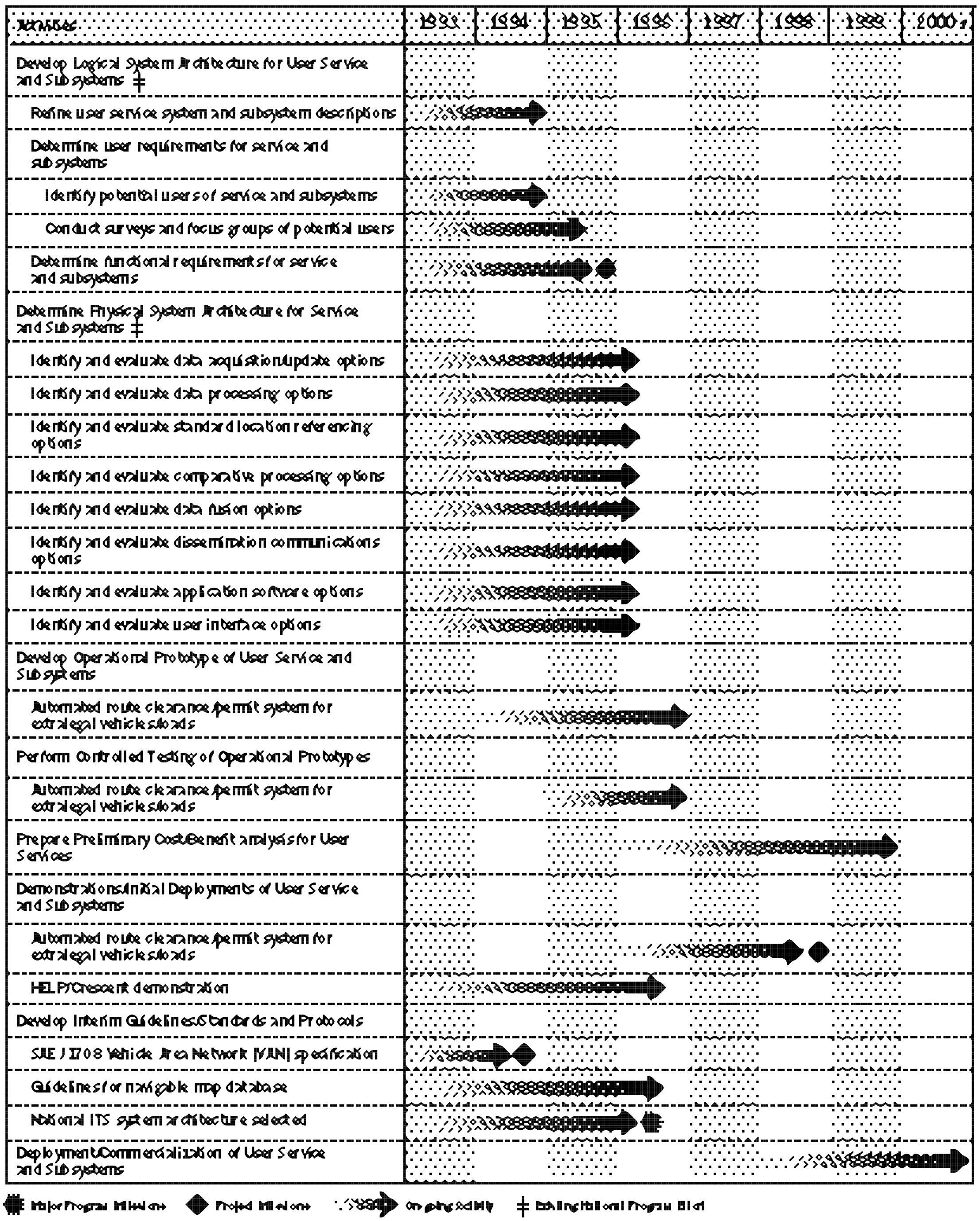
Commercial Fleet Management



Transportation Management Systems

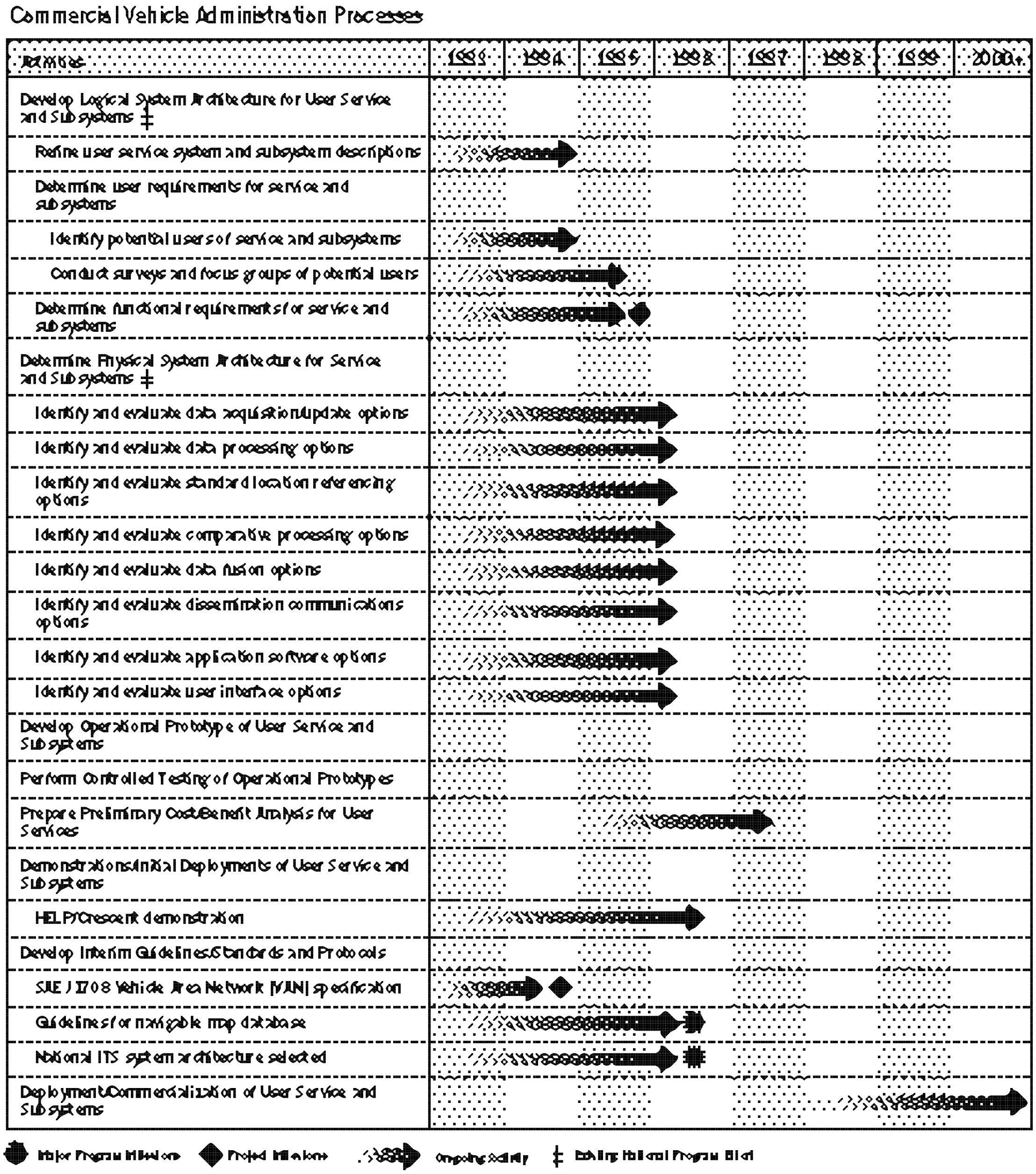
Advanced Fleet Management — Activity Charts

Commercial Vehicle Preclearance



Transportation Management Systems

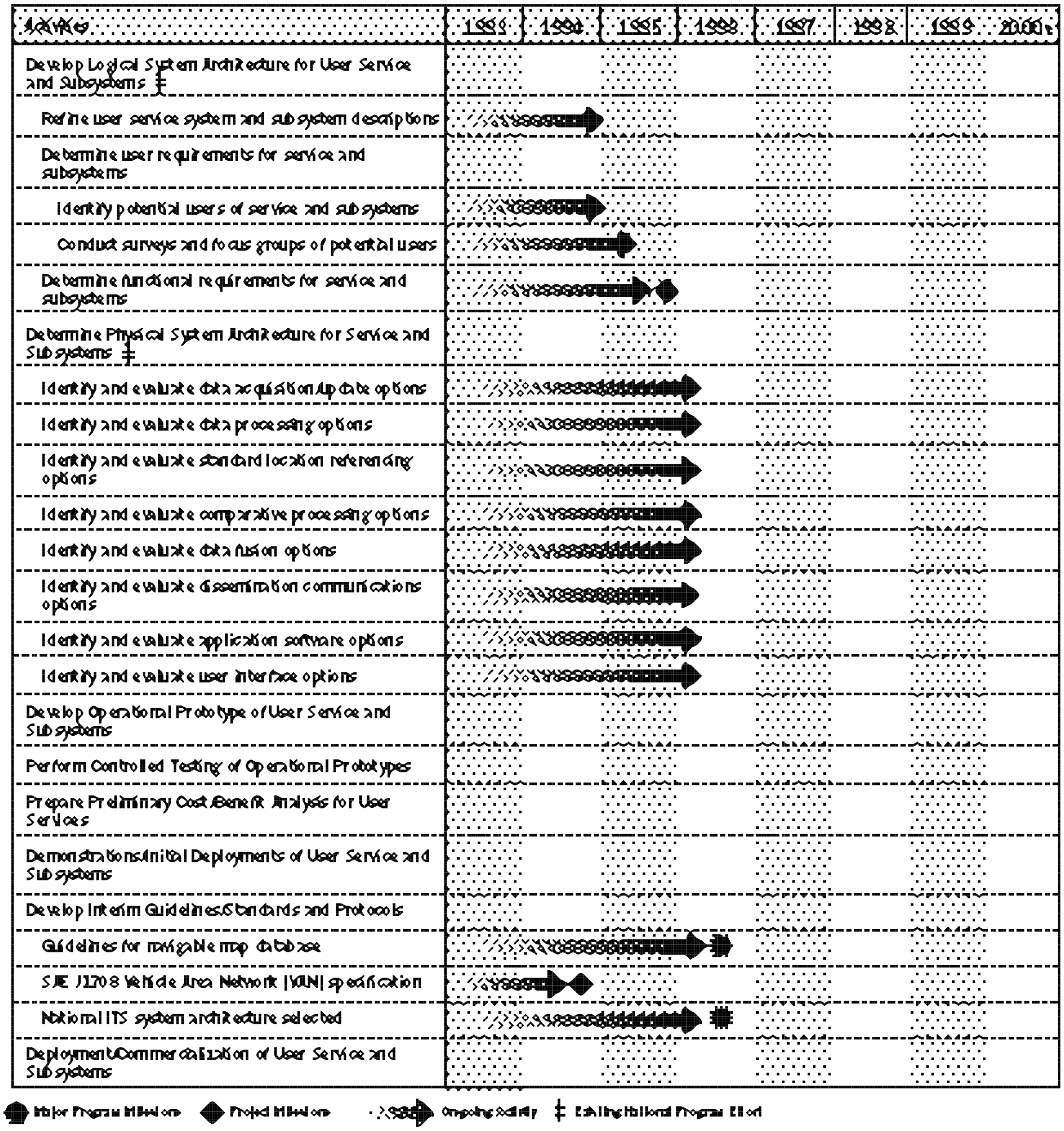
Advanced Fleet Management — Activity Charts



Transportation Management Systems

Advanced Fleet Management — Activity Charts

Emergency Vehicle Management

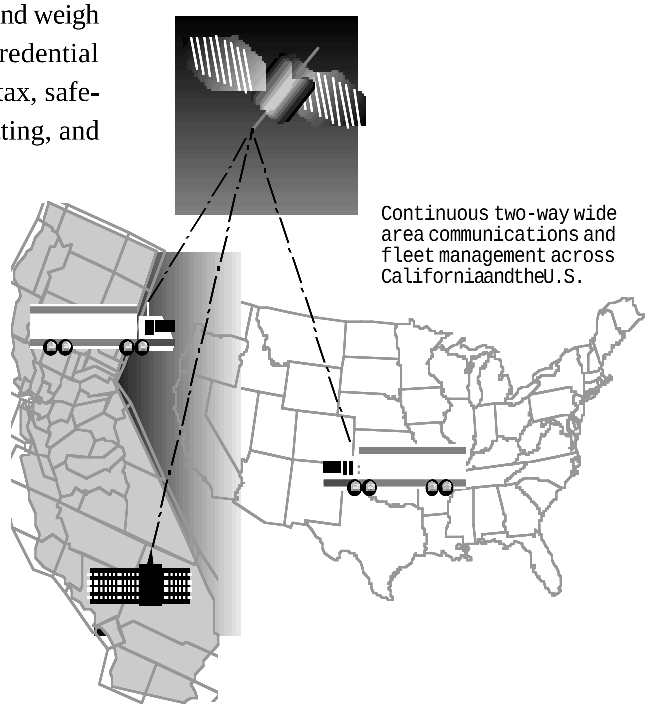


Transportation Management Systems

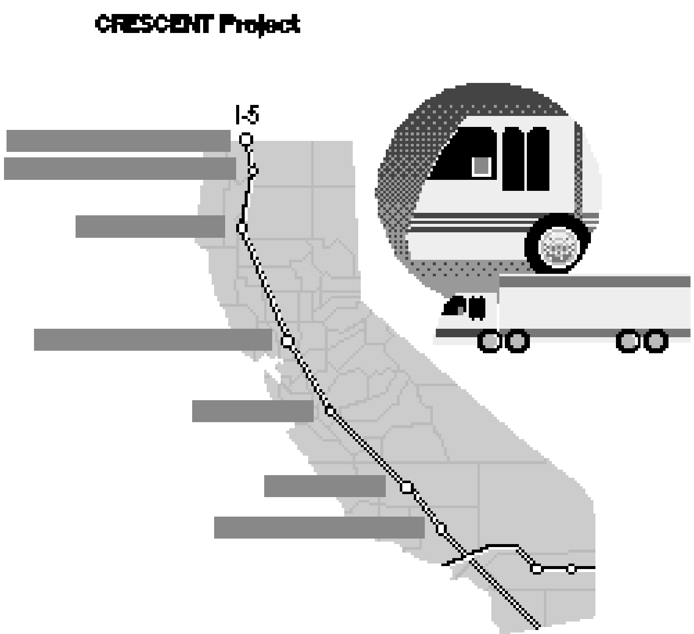
Advanced Fleet Management — Project Highlights

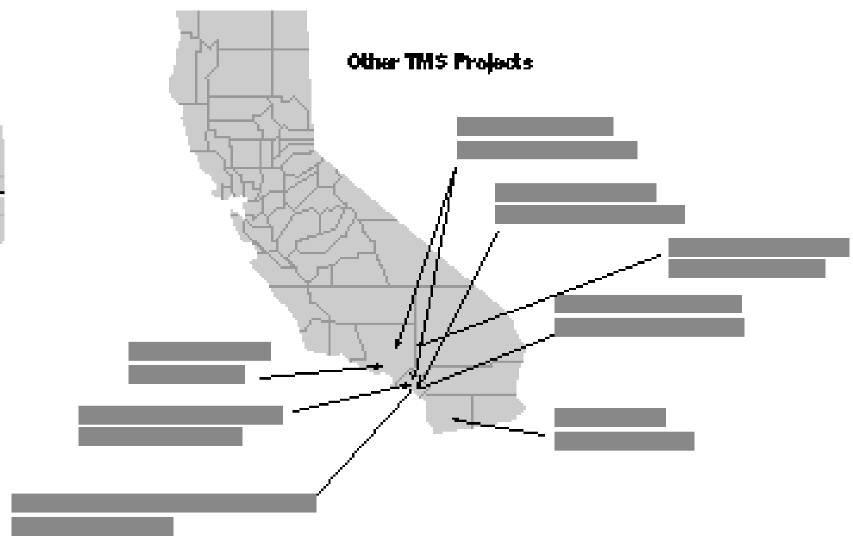
H.E.L.P. Project

The Heavy Vehicle Electronic License Plate Program (H.E.L.P.) is a multistate, multinational research effort to design and test an integrated heavy vehicle monitoring system. Using Automatic Vehicle Identification (AVI), Automatic Vehicle Classification (AVC) and Weigh-In-Motion (WIM) technology, the H.E.L.P. project permits trucks to bypass ports of entry and weigh stations by providing automated credential verifications of registrations, fuel tax, safety, oversize and overweight permitting, and a central data base for fleet information and management. It is expected to be completed in 1996, when it will include preclearance sites in ten states. H.E.L.P. facilities are being installed in California on I-5 and I-10, and are proposed in several other areas, including I-880 in the San Francisco Bay Area.



Continuous two-way wide area communications and fleet management across California and the U.S.





Transportation Management Systems

Intermodal Facilities — Scope

Connectivity of the various modes for people and goods movement can be enhanced through terminal facilities where travelers can transfer from one mode to the other with a minimum of discomfort or where goods can be efficiently moved from one mode to another.

Approaches that will assist with intermodal connectivity are:

- Bringing bus stops, with easily understood signage, close to the disembarkation areas of planes and trains;
- Bringing trains into air terminals to facilitate transfers of passengers and baggage from one mode to the other;
- Establishing safe bicycle storage facilities at transfer points for cyclists to transfer to buses, trains or planes;
- Designating routes on the National Highway System to be "Freight Corridors" to establish design, construction, and maintenance priorities; and, to reduce congestion; and,
- Working at the national level, with public and private organizations, to design programs and secure funding for the advancement of intermodalism as an equal partner in the transportation fabric of California and the United States.

Work to redesign, improve the technology and automate California ports and terminals will be required to realize the full benefits of the ATS highway, rail, waterway and airway infrastructure. Application of ATS at the transfer point ("interfaces") will increase the efficiency and effectiveness of intermodalism for both passengers and goods.

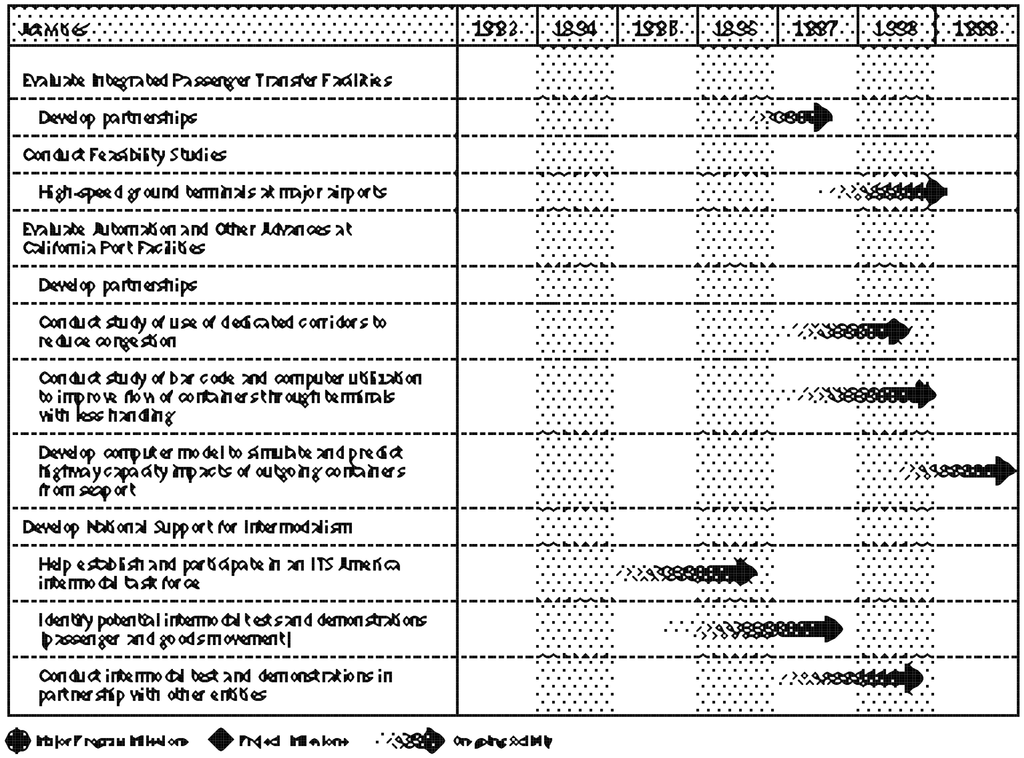
California's extensive port (air/waterway) and waterway system could benefit greatly from the same ATS technologies and coordination being applied to other ground systems. Among the benefits would be improved ground access and maximized efficiency of the "landbridge" across the state and the North American continent (movement of goods inland from seaports and across the continental United States). Examples of applicable technologies are:

- Ship collision avoidance, such as in low visibility areas using digital maps, global positioning systems, computers and wireless communications;
- Vessel routing, tracking and scheduling;
- Vessel fitness monitoring;
- Automated cargo monitoring; and,
- Next-generation port/intermodal transfer facilities.

Transportation Management Systems

Intermodal Facilities — Activity Charts

Intermodal Facilities



Transportation Management Systems

Intermodal Facilities — Project Highlights

In March 1994, ITS America's Coordinating Council established a new task force to investigate including other modes of transportation (rail, air, sea) into an integrated, effective, intermodal transportation system. Caltrans was involved in an Intermodalism Conference late in 1994, to discuss research, development, and demonstration agendas; new initiatives; and, the future direction of "Intermodalism."

Application of information and communication technologies to the interfaces (e.g., terminals) of modal exchange will increase efficiencies, resulting in lower costs and improved safety. This scenario would be especially true in the goods movement area when coupled with management system and logistics planning. With respect to passenger systems, improvement at the interfaces will also increase the attractiveness of using public transportation.

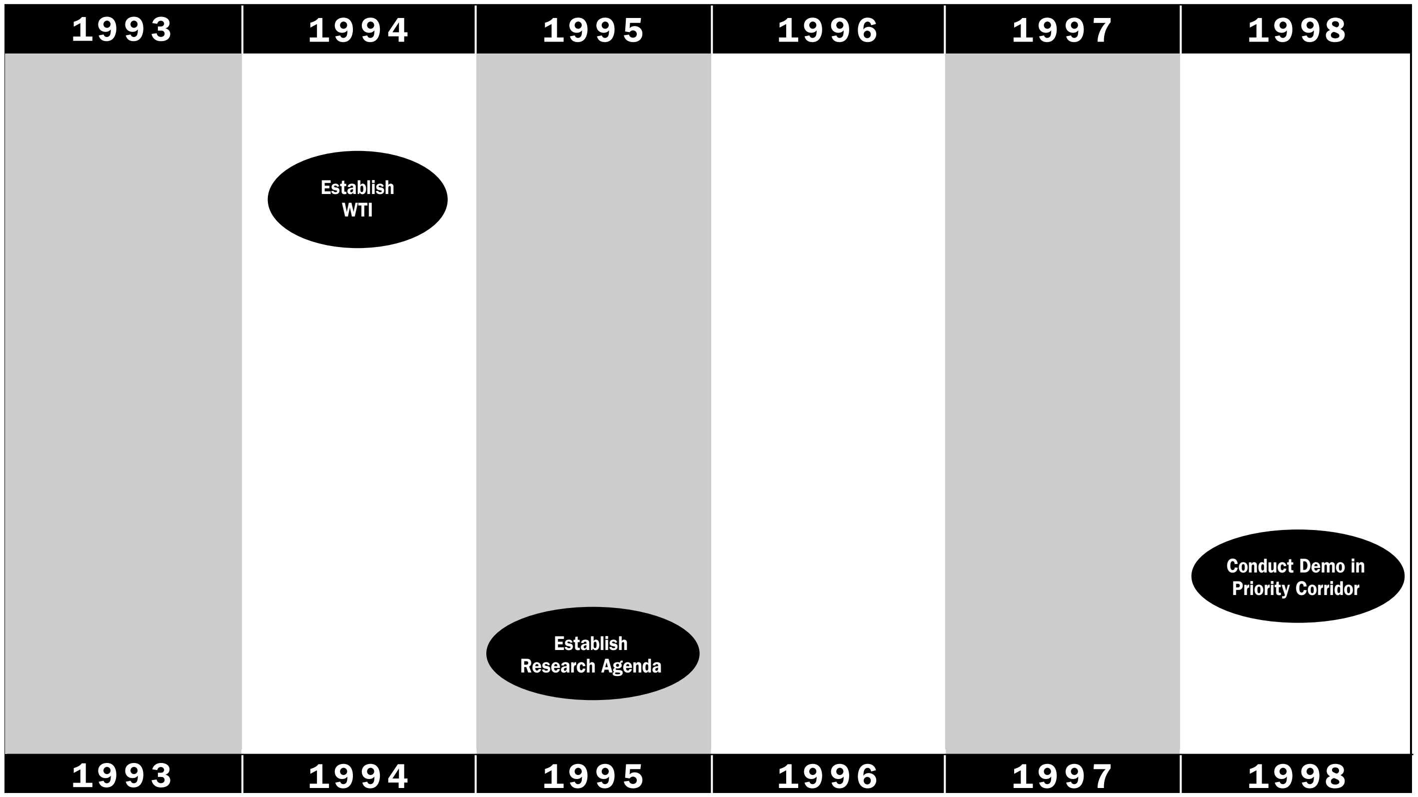
Projects being sponsored to encourage intermodal transportation usage by the public will include "off-airport terminals" construction, operation and evaluation to provide congestion relief at airports; studies and recommendations to extend rail facilities into or closer to air terminals to encourage use of alternate modes of transportation; and, studies to determine ways to lessen the impact of port side operations that affect truck usage of adjacent roads and highways.

RURAL

The rural transportation program focuses on the transportation concerns of rural California to assure the appropriate application of advanced transportation technologies to rural transportation problems.

The milestones, scope of services, activities and project highlights for Rural Transportation are discussed on the following pages.

Rural Transportation



Rural Transportation

Scope

Increased interest in rural transportation issues in the new technology/intelligent transportation systems arena is a fairly recent development. Because federal, state and local officials have been overwhelmed by the problems plaguing urban transportation, such as traffic congestion, and related air quality, noise and energy issues, little time, or resources have been devoted to rural transportation issues.

Two-lane rural highways are the backbone of the rural transportation network. These roads carry local traffic, as well as commercial vehicles, transit vehicles, school buses, and recreation and commuter traffic. Additionally, there is a system of multi-lane divided highways that serve metropolitan centers and traverse rural areas. Like urban transportation, rural transportation is also concerned with air quality control and energy conservation. While the primary focus of urban transportation may be traffic congestion, the primary focus of rural transportation technology is safety.

In 1992, the Caltrans New Technology and Research Program embarked on a research study, the “Program for Advancing Rural Transportation Technology” (PARTT). The purpose of PARTT is to focus proper attention on the transportation concerns of rural California and to assure the appropriate application of advanced transportation technology to rural transportation problems.

Directly attributed to this research study are the following successful results:

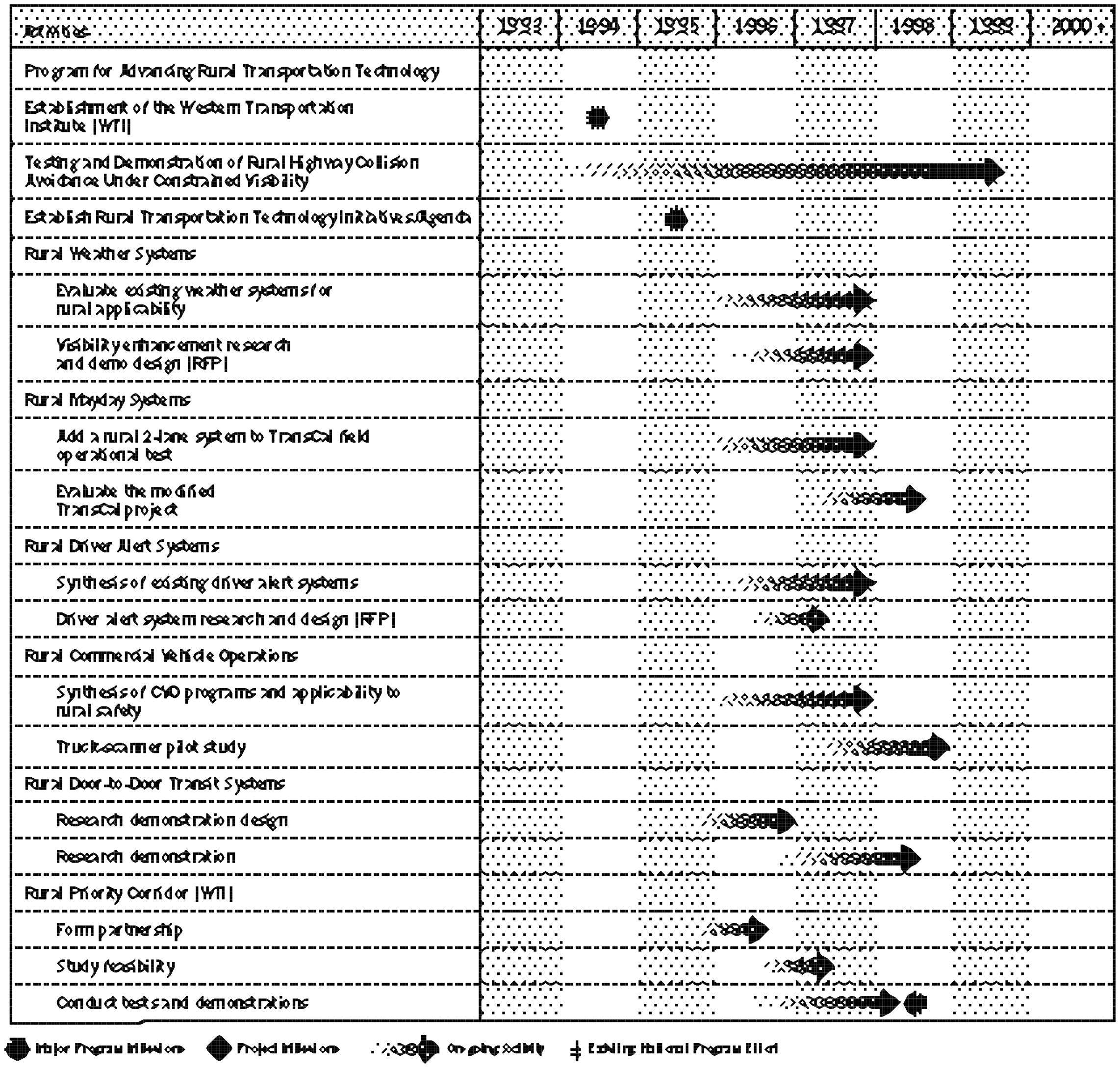
- The first national discussion on advanced rural transportation technology in the second draft of the “ITS America Strategic Plan” (January 1992);
- Establishment of an ITS America Committee to deal specifically with rural transportation technology concerns (ITS America Advanced Rural Transportation Committee, April 1992);
- The first rural transportation technology conference sponsored by Caltrans (Redding, California, September 1992); and,
- The Western Transportation Institute (WTI) established in 1994.

In addition, with ITS America, the WTI and other partners, Caltrans will help establish a formal rural technology research agenda.

Rural Transportation

Activity Charts

Rural Transportation



Rural Transportation

Project Highlights

The Western Transportation Institute — A Western Center for Rural Transportation Excellence

The Western Transportation Institute (WTI) was established in 1994, to pursue research and education in Intelligent Transportation Systems (ITS) and other rural transportation matters. WTI maintains close ties with other ITS programs nationally, including PATH.

WTI is also affiliated with many national ITS programs and organizations including the NAHSC, the National ITS System Architecture Program and ITS America. WTI, with participation from government, industry and academia, is currently working to establish a national ITS rural priority corridor for demonstration and deployment of promising rural transportation technology.

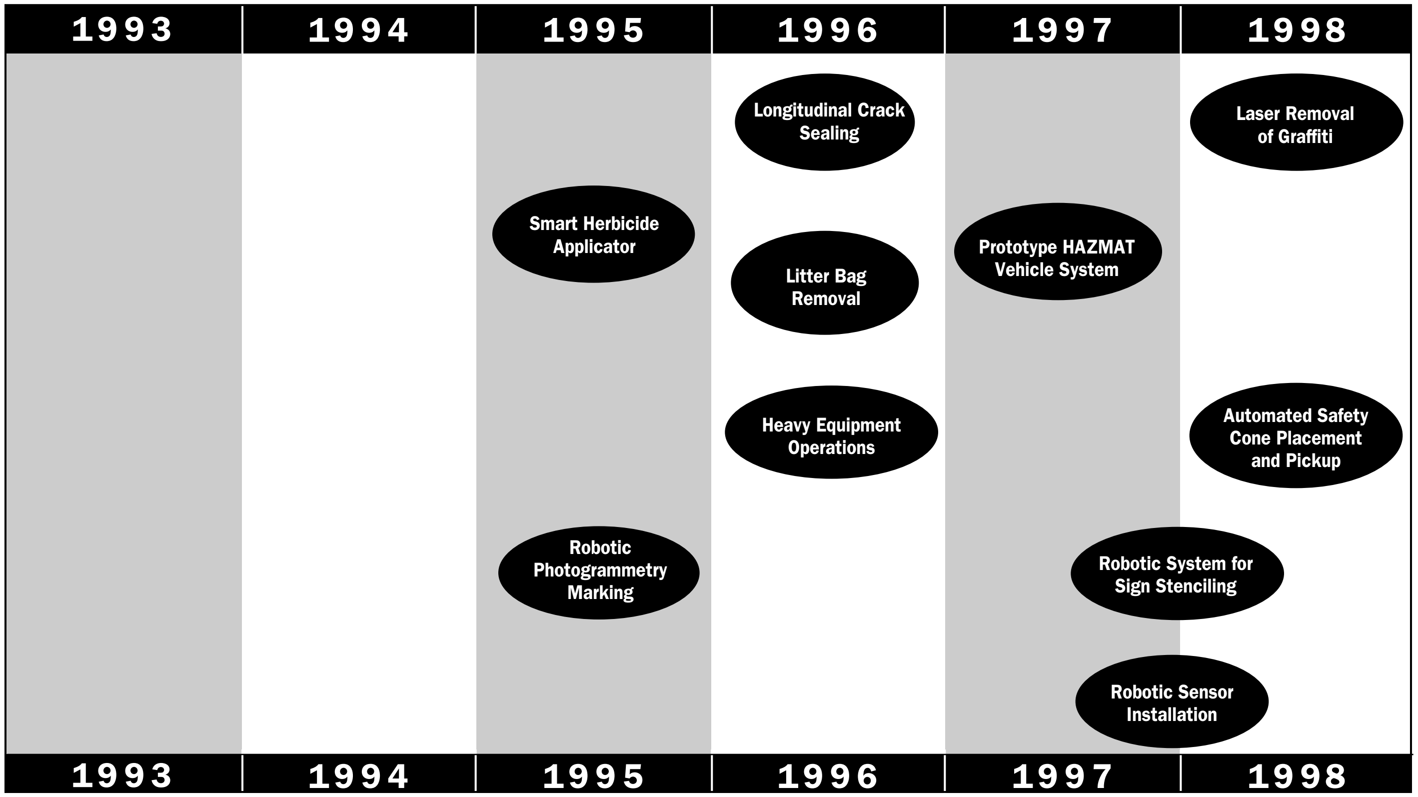
INFRASTRUCTURE CONSTRUCTION AND MAINTENANCE

- *Roadway Maintenance and Construction Technology*
- *Roadside Maintenance and Construction Technology*
- *Structure Maintenance and Construction Technology*
- *Workzone Safety Enhancements*
- *ITS/AHS Related Infrastructure Maintenance and Construction*

Infrastructure Construction and Maintenance is a program that employs technological developments, such as automation and robotics, to develop products and processes that improve the efficiency and safety of traditional highway construction and maintenance operations.

The milestones, scope of services, activities and specific project highlights for Infrastructure Construction and Maintenance are discussed on the following pages.

Infrastructure Construction/Maintenance



Infrastructure Construction & Maintenance

Scope

Current efforts by the Advanced Highway Maintenance and Construction Technology (AHMCT) Center include the development of technologies such as external sensing systems, manipulation systems, control and coordination systems, communication systems, material storage and retrieval systems, mobility systems, and human-machine interfaces. These technologies are critical to the development of automated or robotic equipment intended for transportation maintenance and construction.

The jointly staffed University of California, Davis/Caltrans AHMCT Center has developed expertise in these areas; has an understanding of current and emerging robotic and automation technology and has specifically researched future trends in technology applicable to automation of construction and maintenance tasks.

- **Roadway Maintenance and Construction Technology**

Of prime importance to Caltrans is the effective maintenance of road surfaces and pavement delineations in the form of lane striping, pavement markers and pavement and roadside signage. Efforts are underway to introduce automation and robotic technology to conventionally slow, labor intensive and potentially unsafe operations. Examples of activities under investigation include: sealing pavement cracks; painting pavement markings, including survey premarks; and, placing raised pavement markers on the pavement at prevailing speeds. These technological advances will eliminate the exposure of maintenance personnel to moving vehicles and have the potential to transform a static lane closure into a moving operation.

- **Roadside Maintenance and Construction Technology**

Caltrans is responsible for maintaining the roadside right-of-way, including landscape management, refuse and graffiti cleanup, and removal of hazardous materials. Landscape maintenance efforts are designed to limit employee exposure to the dangers of moving vehicles while performing landscape maintenance operations. Research is also aimed at substantially reducing water and herbicide usage and developing landscape vegetation suited to reduced maintenance and watering. Innovations in the areas of litter pickup equipment, remote landscape management systems, graffiti removal and prevention, and rapid and remote hazardous material spill identification and remediation are being researched. These developments will ultimately reduce employee exposure to highly toxic materials and reduce the time necessary for lane closures occurring during landscape maintenance operations.

- **Structure Maintenance and Construction Technology**

The development of methods and equipment for rapid and remote inspection of bridge components and other structures is critical to maintaining the safe condition of a deteriorating transportation infrastructure. The nation's large inventory of aging elevated structures mandates frequent and detailed inspections using equipment of increasing sophistication. Efforts in this area focus on the development of products that will allow remote inspection of structural facilities, while reducing human risk and improving efficiency.

- **Workzone Safety Enhancement**

A wide variety of devices and processes has been developed to enhance the safety of field workers, including such products as hard hats, highly visible garments, safety cones, equipment backup signaling, and lane closure procedures. These and many other products and procedures have been adopted by the construction industry with life-saving success. Products continue to be developed at a rapid pace, as the desire to improve workzone safety continues. Recently, many products, such as workzone intrusion warning systems, vehicle sensors to prevent equipment or equipment/human collisions, and garment sensors used to alert workers of the approach of heavy equipment, have become sophisticated through the advent of the computer and sensor revolution. While research in other areas is directed towards eliminating the necessity for workers to be exposed on the roadway, the mission of workzone safety research at the AHMCT Center is to substantially increase the safety of workers both on and off the roadway.

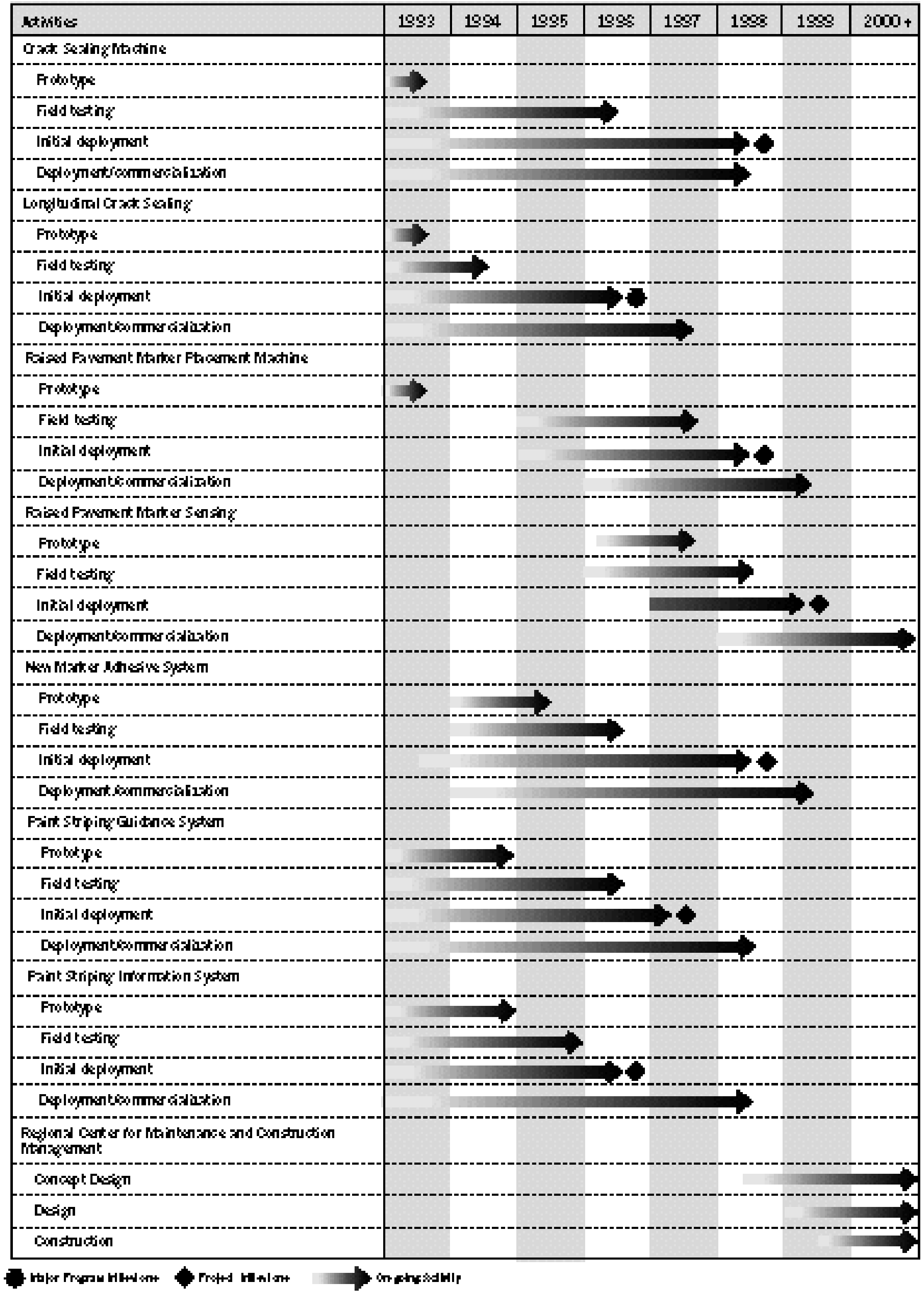
- **ITS/AHS Related Infrastructure Maintenance and Construction**

As more technologically advanced transportation systems are implemented, construction and maintenance operations will become more complex. ITS construction and maintenance will require accurate equipment positioning, frequent testing, and rapid repair of control and communication instrumentation. Such achievements will be critical to automated transportation systems. Recent advances in design for automated assembly, manufacturability, and life cycle, have sanctioned the evaluation and development of new concepts for automated construction and maintenance of a demanding ITS infrastructure.

Infrastructure Construction & Maintenance

Activity Charts

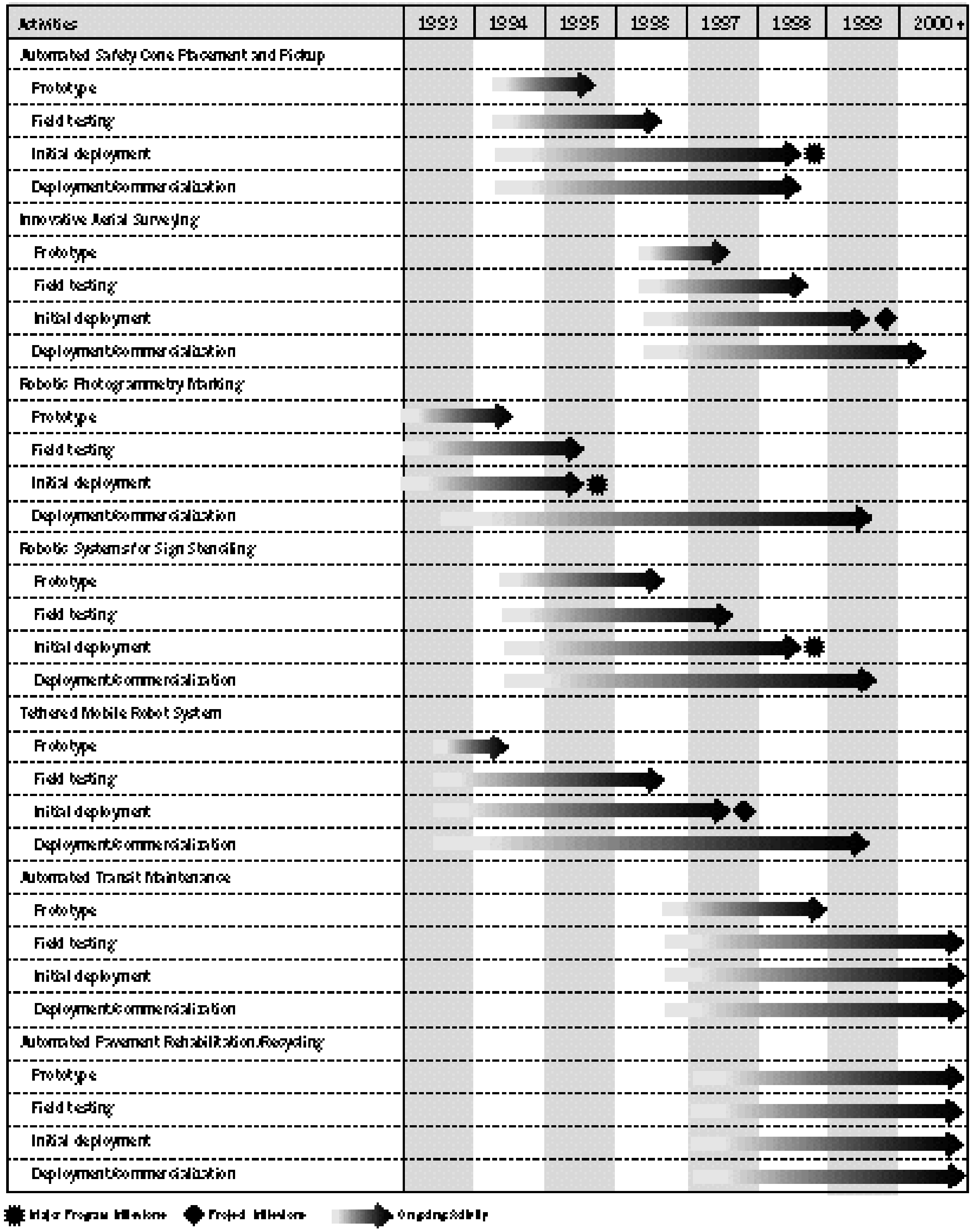
Roadway Maintenance & Construction



Infrastructure Construction & Maintenance

Activity Charts

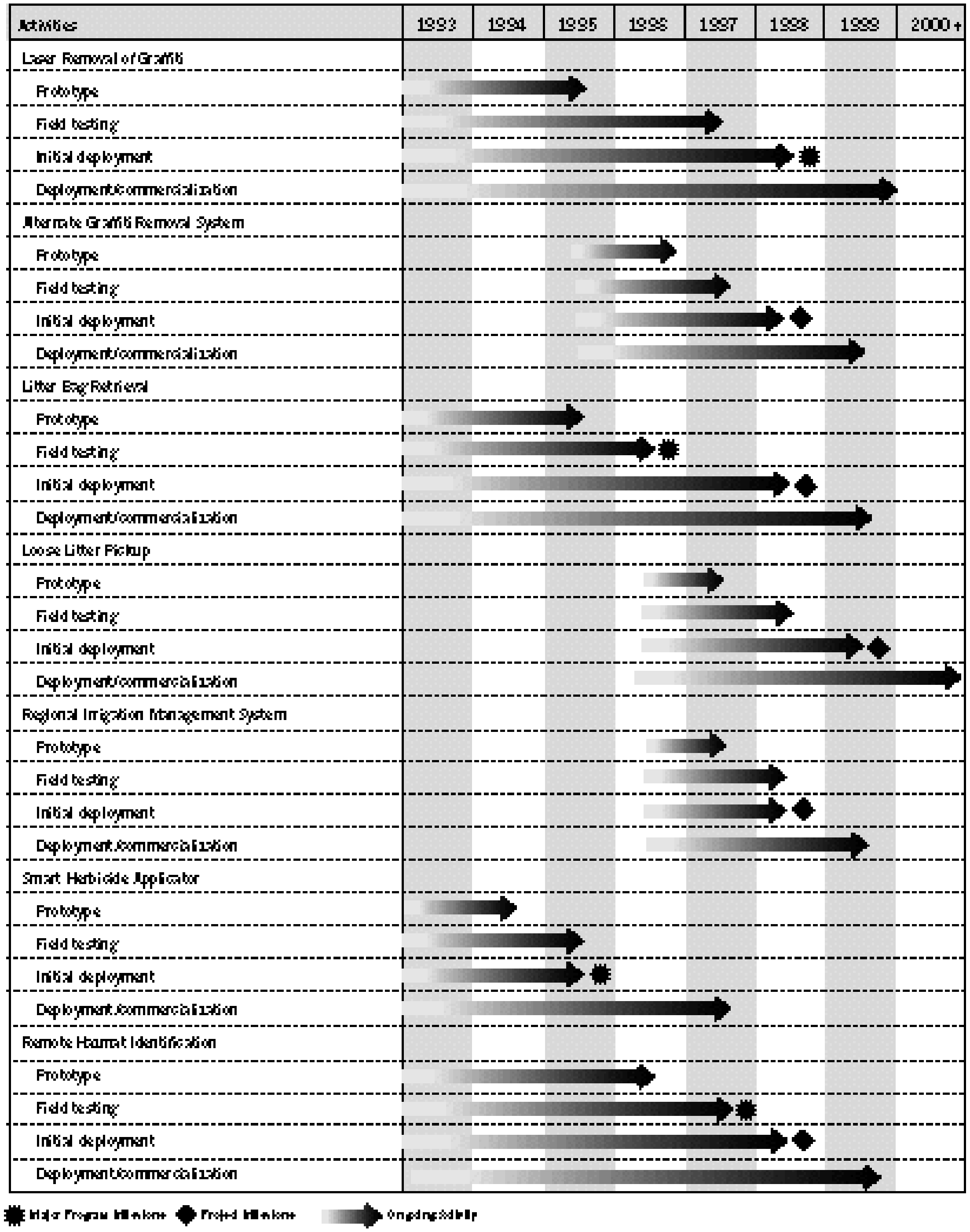
Roadway Maintenance & Construction cont'd



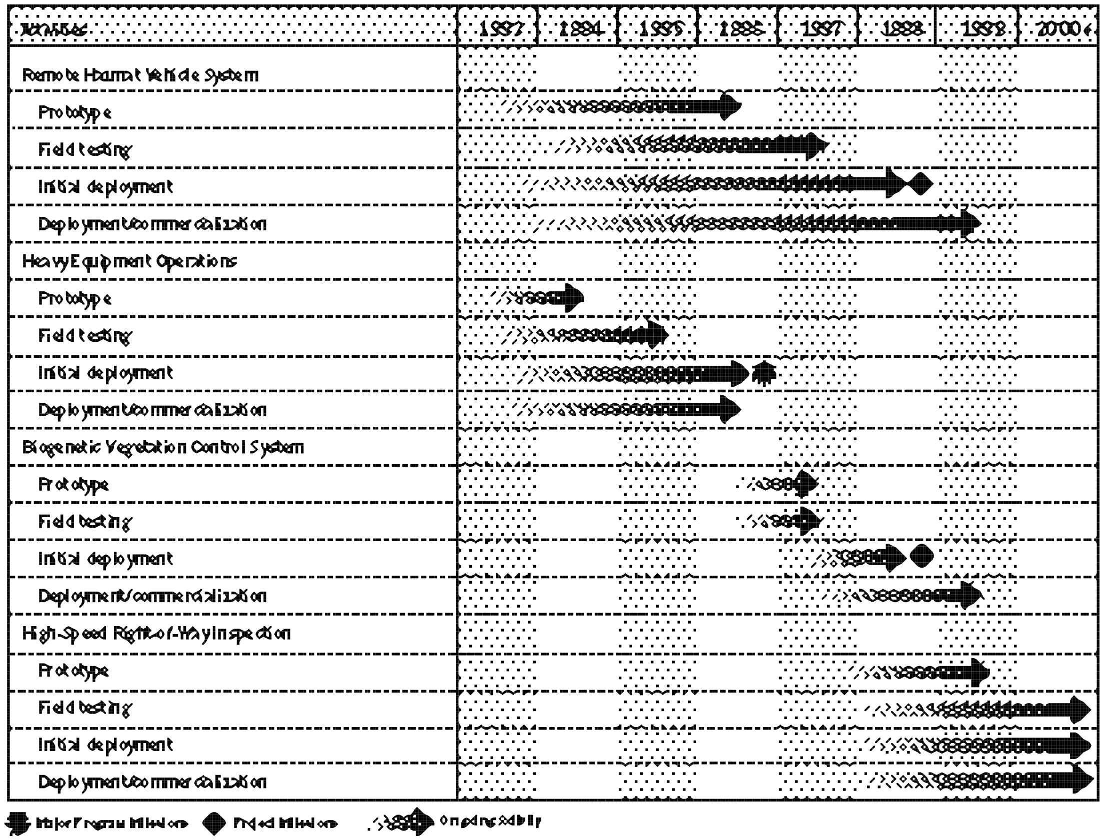
Infrastructure Construction & Maintenance

Activity Charts

Roadside Maintenance & Construction



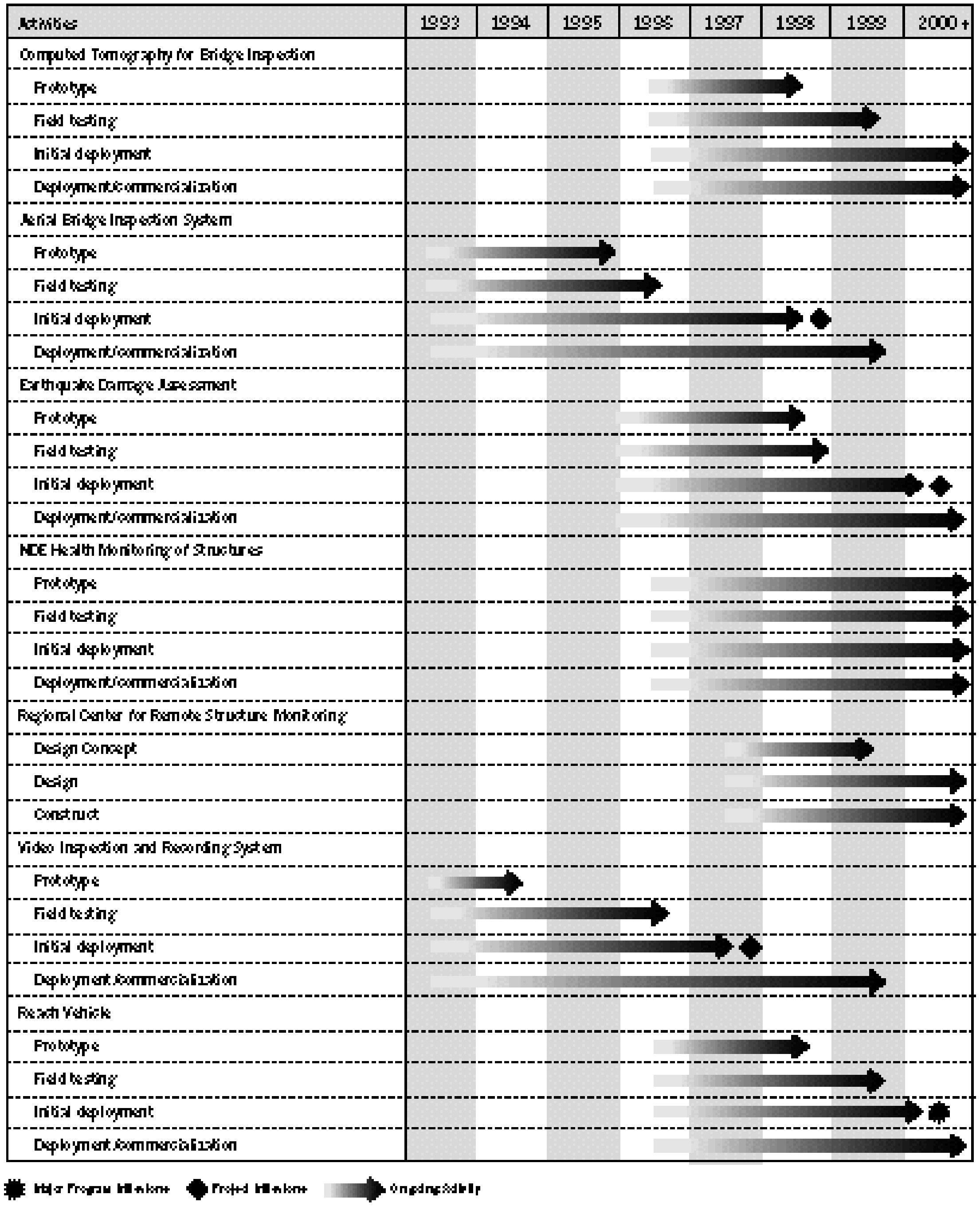
Roadside Maintenance & Construction cont'd



Infrastructure Construction & Maintenance

Activity Charts

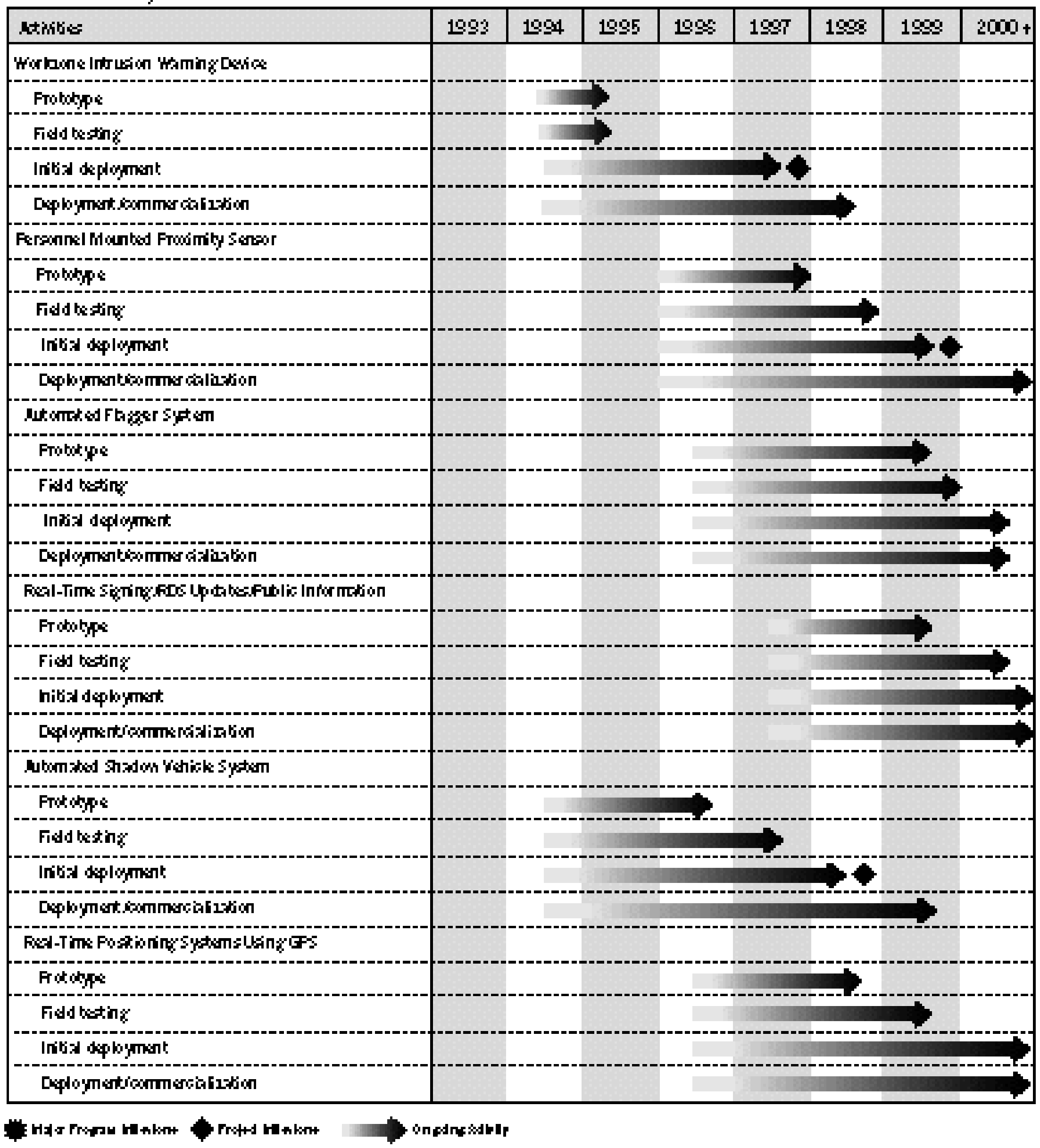
Structure Maintenance & Construction



Infrastructure Construction & Maintenance

Activity Charts

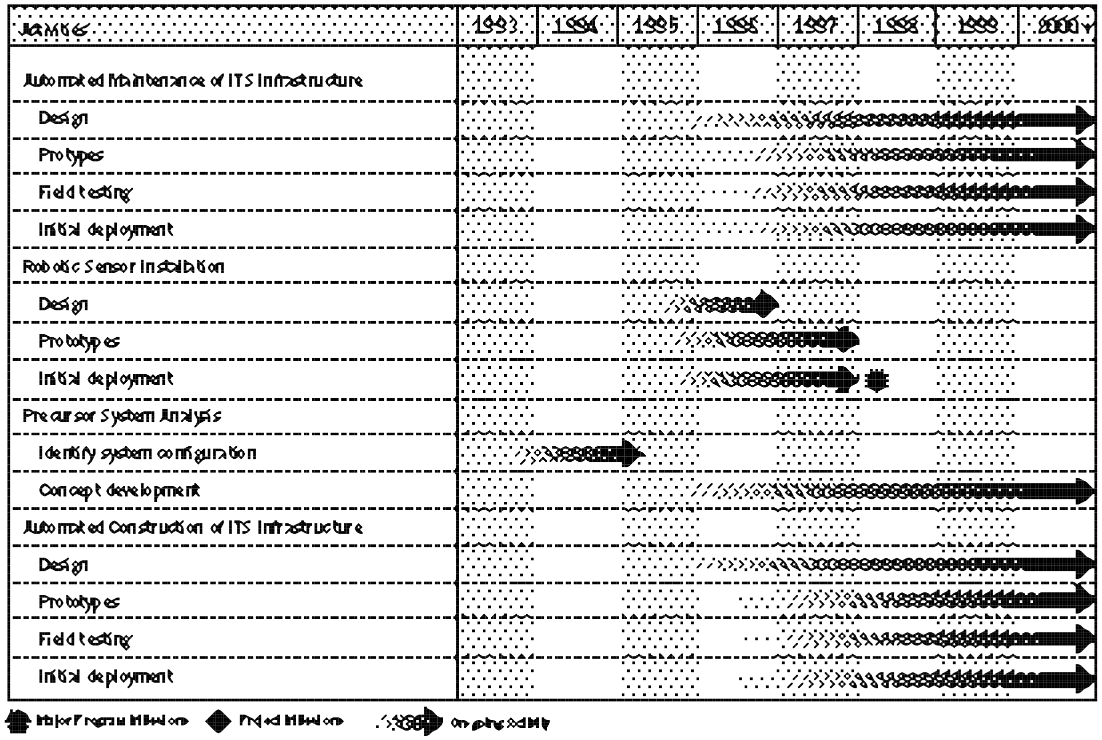
Workzone Safety Enhancements



Infrastructure Construction & Maintenance

Activity Charts

ITS/AHS Infrastructure Maintenance and Construction



The following AHMCT projects show the most immediate potential for commercialization or extensive field prototype operation:

Crack Sealing Machine

The Automated Crack Sealing Machine (ACSM) is a self-contained prototype vehicle for automatic identification, preparation, and sealing of roadway cracks—a conventionally dangerous, slow, and labor-intensive operation. This vehicle will increase the efficiency of crack sealing and enhance the safety of maintenance workers and the traveling public, as well as reduce the time necessary for lane closures.

The vehicle is equipped with a vision system, a robot positioning system, and computer and mechanical support systems. During automated operation, the vision sensing system detects the position of cracks, including their orientation, while the relative position of the vehicle is continuously monitored by a dead-reckoning system. The crack data is buffered and processed by modules which determine the order of cracks to be sealed as they become accessible in the sealing workspace and positions the robotic arm with a custom sealant head along the calculated crack positions. The sealant head, custom designed to fill and seal any size crack according to standard specifications, is so innovative that interest from maintenance and industry personnel has encouraged accelerated efforts to commercialize it as an independent material delivery module.

A longitudinal crack sealing vehicle has been developed to seal only the continuous pavement joints along lanes. The quick-moving vehicle uses the same custom sealant head as the general crack sealing machine, and has been tested in Caltrans District 2 (Redding), District 3 (Marysville) and District 11 (San Diego).

Robotic System for Sign Stenciling

The traditional method of stenciling is a very slow, labor-intensive operation that requires manual placement of a stencil and paint, exposing maintenance workers and the traveling public to hazards. The goal of the new stenciling system is to improve the safety, reliability and efficiency of the roadway sign stenciling operation through the application of automation and robotic technologies. The first prototype resulting from this project focuses on the stenciling of survey premarks for photogrammetry. Using the automated stenciling system, a single operator can accurately complete the painting operation from within the cab of the maintenance vehicle in a fraction of the half-day-per-mile required by the traditional four-person survey crew. By eliminating or reducing the exposure of workers to traffic, the safety, speed, and efficiency of the stenciling operation is significantly improved.

Crack sealing machine prototype testing, District 3 (Marysville)

Infrastructure Construction & Maintenance

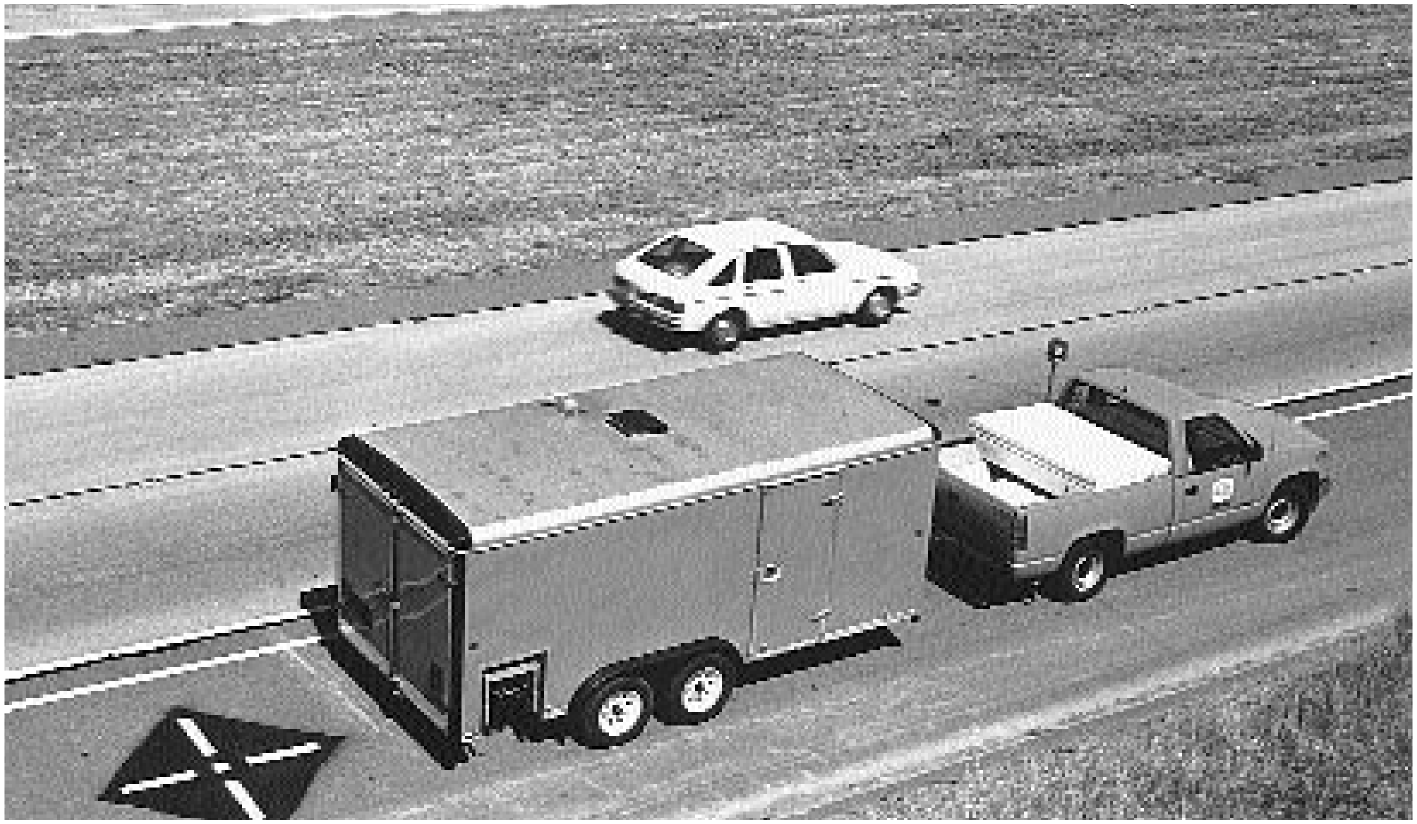
Project Highlights

TAMER equipment in operation. Both of the methods shown, the backpack unit and stationary console, are available for remote operation.

Remote-Control Heavy Equipment

Heavy equipment such as crawler tractors, dozers, and loaders, are often used in hazardous situations such as clearing avalanches, landslides, and snow, as well as cleaning up hazardous materials. The respective equipment operators are by necessity exposed to this high-risk, unstable environment. Remote controlled capability permits the operator to control the equipment from a safe distance when the conventional operation is deemed dangerous. The remote distance for reliable operation is 488 meters (1600 ft).

Teleoperated and Automated Equipment Robotics (TAMER) technology has most recently been applied to a Caltrans front-end loader. It is anticipated that such a remote-control system could also be adapted to other existing maintenance and construction equipment.



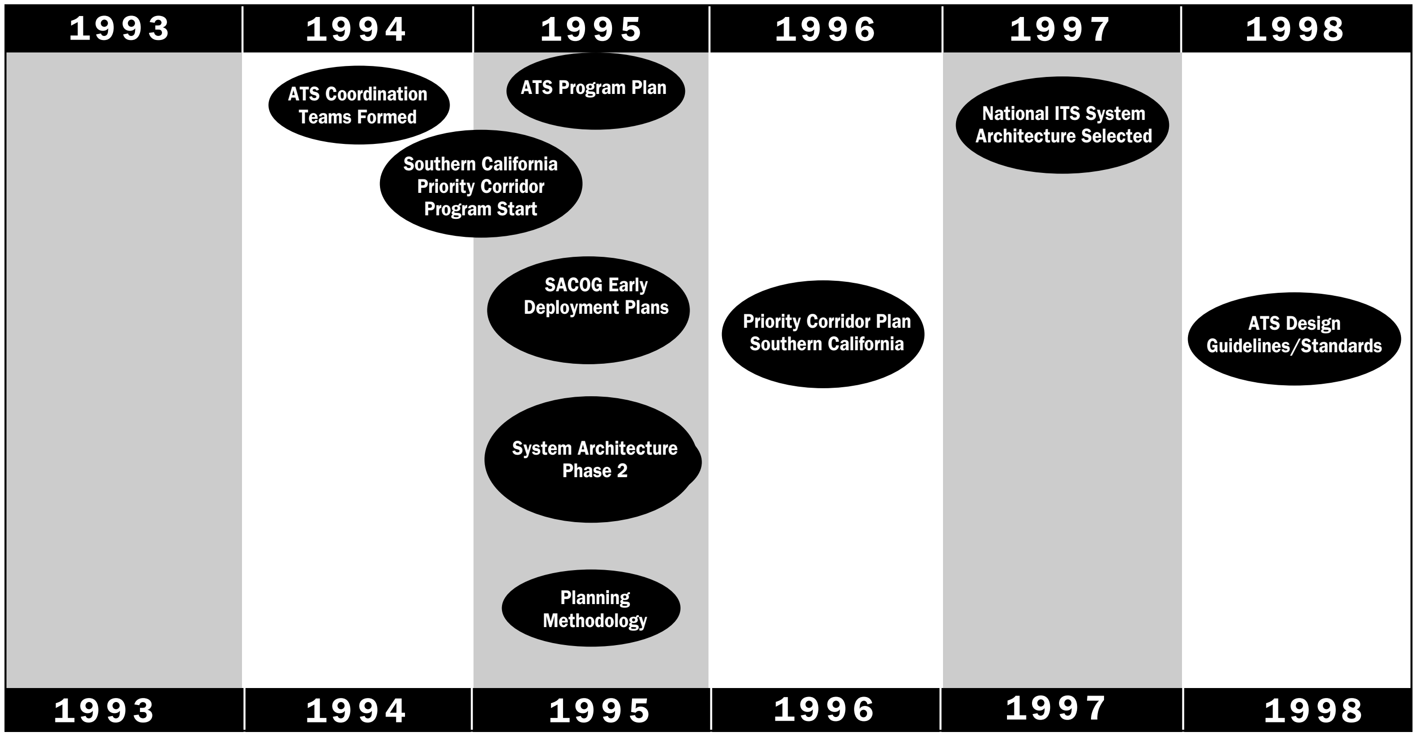
Robotic System for Sign Stenciling in operation.

SYSTEMS DEVELOPMENT, INTEGRATION AND IMPLEMENTATION

Systems Development, Integration and Implementation includes Caltrans involvement in integrated systems design and operation framework; planning, programming and environmental aspects, as well as legal and institutional issues associated with the deployment of advanced transportation technologies in California.

The milestones, scope of services, activities and specific project highlights for Systems Development, Integration and Implementation are discussed on the following pages.

System Development, Integration and Implementation



Systems Development, Integration and Implementation

System Architecture-Scope

ITS Architecture Definition

An ITS architecture is a framework that defines the system elements, determines their functions, and describes how the elements interact with each other. It describes the system operation by what data is collected, what information is distributed, and the means by which that is accomplished. The framework is presented via charts and diagrams, along with narratives. The architecture framework is *not* a system hardware or software design and it is not a policy decision or directive.

System architecture presents the total perspective to aid in the analysis and design of the individual ITS parts while taking into consideration the needs and constraints of the transportation system as a whole. Within this context, the objectives for the ATS Program are to:

- Define an integrated system design and operational framework. The best approach to designing such a framework is to develop an overall system architecture that will determine not only the functions of individual components, but more importantly, their connectivities (design) and interrelationships (operation);
- Analyze the system-level aspects that could create problems or have impacts on the system as a whole, and not necessarily on its individual parts. Such problems would apply to system modeling of interconnection/communications, design, human factors, reliability, optimization, openness, and full automation;
- Synthesize and integrate the various components and subsystems as they are being developed, produced, and deployed to insure their connection, the correction of deficiencies, and elimination of duplication and unwanted redundancies; and,
- Synchronize research and development, as well as deployment work across all programs to ensure efficient use of time and resources, as well as satisfactory progress and timely completion of tasks.

The degree to which these objectives are accomplished determines how timely and complete the intermodal advanced transportation system can be, as well as how efficiently and harmoniously it will operate.

Significance of the ITS Architecture

The significance of the ITS architecture stems from its ability to allow nationwide deployment of compatible transportation systems and synergistic transportation services. The architecture's significance is manifested by its stated objectives which are:

- Promote national compatibility via determining and implementing national standards and protocols for vehicle-to-vehicle and vehicle-to-infrastructure communications;
- Facilitate ITS user service integration via a framework for integrating data collection, data transmission, information processing, information dissemination, traffic control, and intermodal transportation system functions;
- Accommodate new and evolving user services via a structural framework of basic building blocks for incorporating new systems and functions; and,
- Provide regional, institutional, and consumer decision-making flexibility in implementing ITS systems without weakening the above three objective benefits.

Caltrans' Involvement in the National System Architecture Program

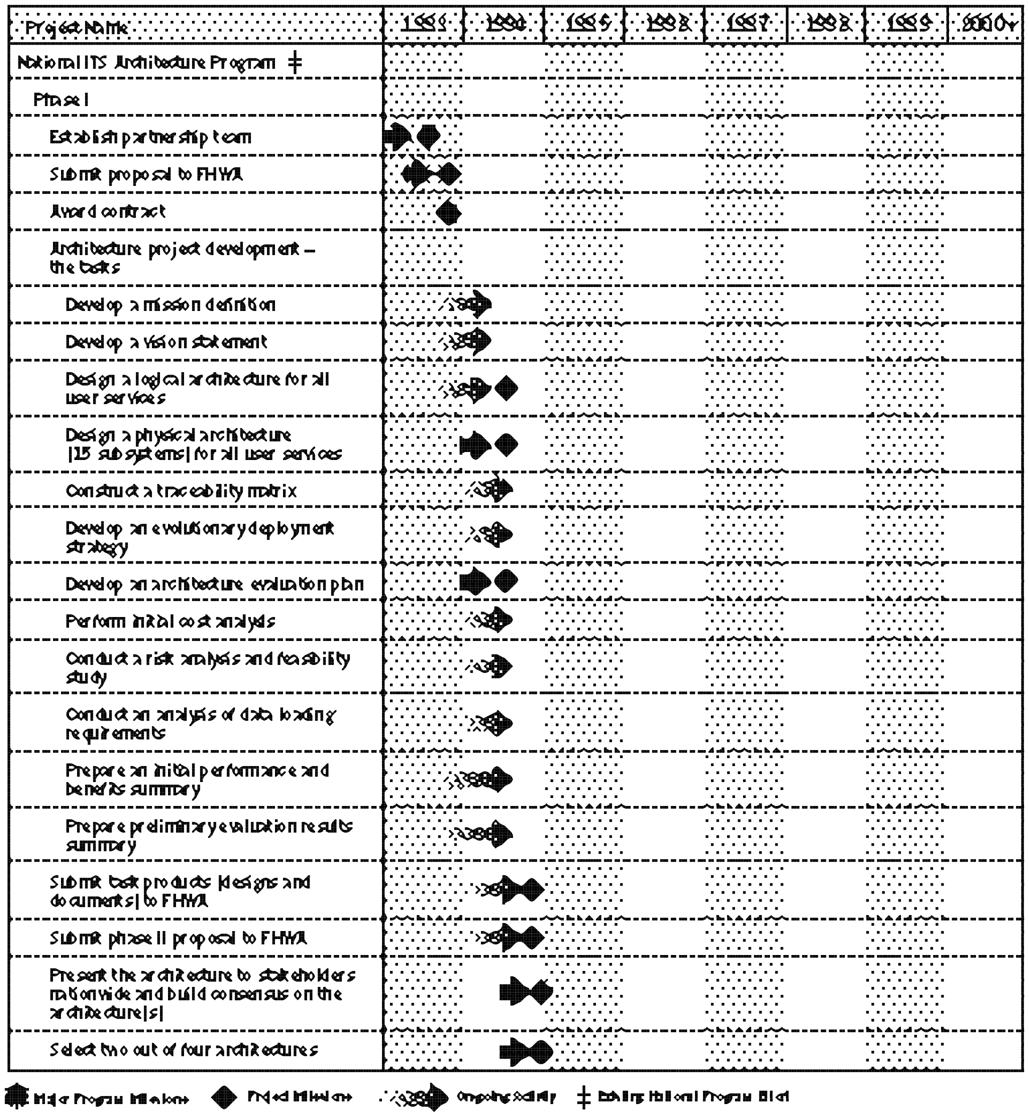
Caltrans is an active participant in the Architecture development process to:

- Insure that California traffic congestion problems and transportation system needs are well addressed;
- Influence the design of the national architecture so it leverages and maximizes the utilization of California's existing transportation infrastructure, as well as California's future plans and investments in the transportation systems;
- Insure that future transportation systems in California are designed/deployed to fit well within the emerging national ITS architectural framework; and
- Share Caltrans' experiences with, and provide expertise to, the FHWA, as well as to the rest of the states' DOTs.

Systems Development, Integration and Implementation

System Architecture-Activity Charts

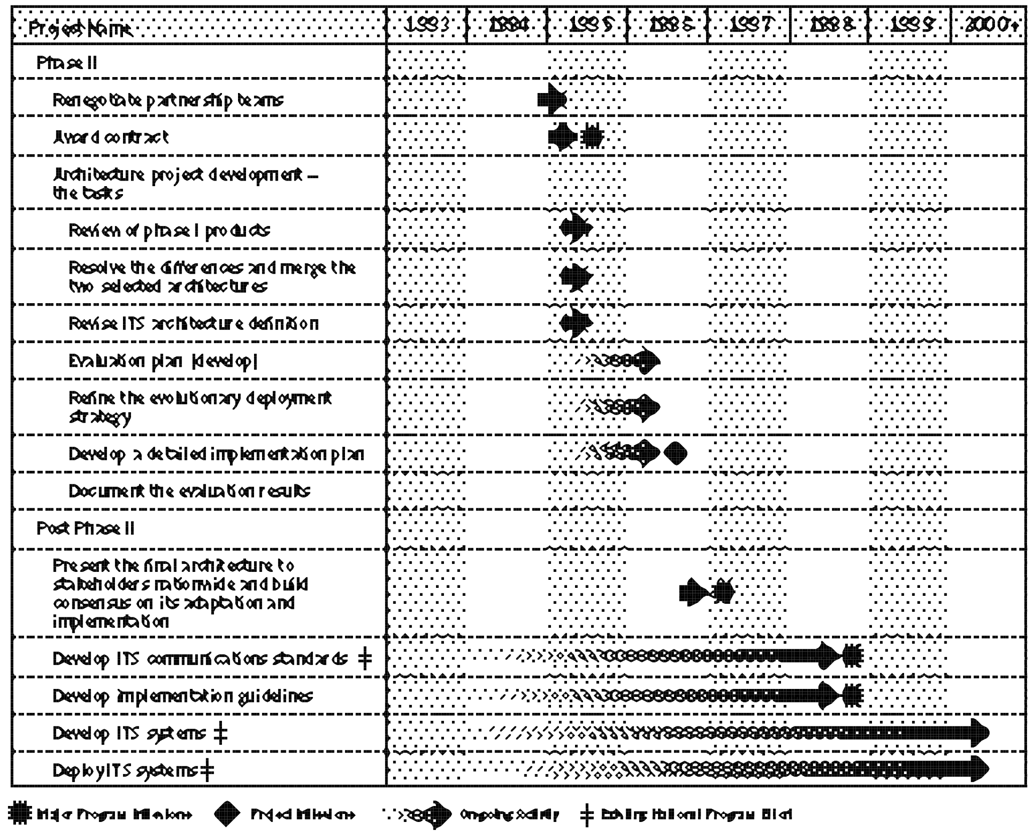
System Architecture



Systems Development, Integration and Implementation

System Architecture-Activity Charts

System Architecture contd



Systems Development, Integration and Implementation

Institutional and Legal Issues - Scope

For Caltrans, the scope of institutional and legal issues covers planning, programming and environmental needs, as well as legal and institutional barriers. Caltrans, in cooperation with all levels of government, the private sector, academia, and various interest groups, is working on several fronts to help assure timely and responsible deployment of advanced transportation systems in California. Examples include:

- Caltrans is working with its partners to establish regional teams throughout the state to coordinate ATS programs and activities and help facilitate ATS deployment;
- Caltrans, in cooperation with local and regional agencies, is preparing the Southern California Priority Corridor Plan as provided for in ISTEA to showcase ITS technologies in Southern California (see Project Highlights); and,
- Caltrans, in cooperation with ITS America and the Federal Highway Administration, co-sponsored a policy conference on air quality in June 1994. This was the third conference in a series addressing the relationship of ITS to air quality.

Caltrans is considering state policy and legislative initiatives that will support ATS and related economic endeavors such as:

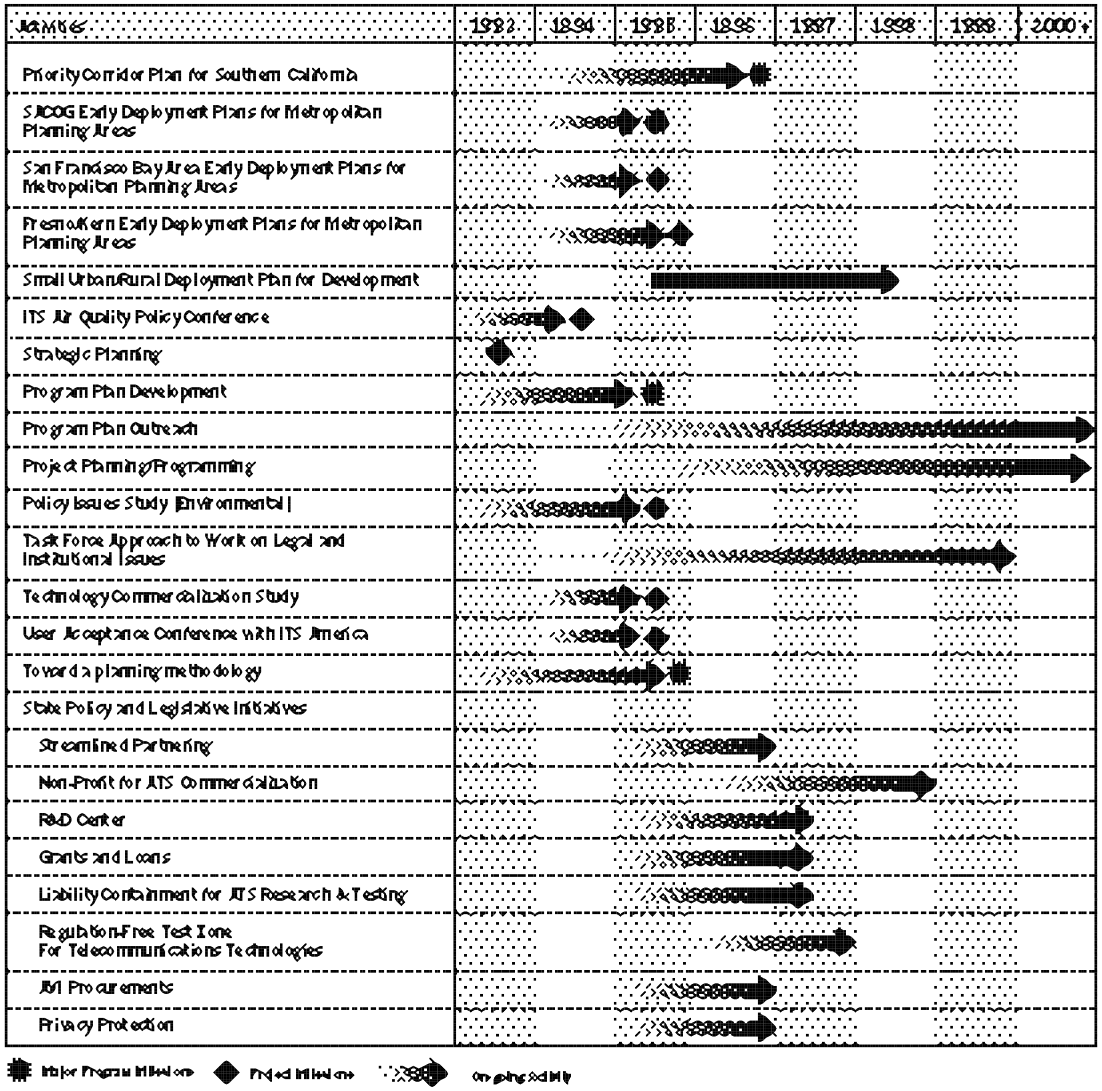
- Streamlined partnering arrangements for the program
- Non-profit corporation for ATS commercialization
- Grants and loans for ATS innovations by small businesses
- Liability containment for ATS research and testing in California
- Regulation-free test zone for telecommunication technologies
- AVI procurements for public fleet vehicles
- Privacy protection in ATS deployment

The five-year activity charts for these and other activities provide the institutional base for ultimate deployment of advanced transportation systems, products, policies and services.

Systems Development, Integration and Implementation

Institutional and Legal Issues - Activity Charts

Institutional Issues



Systems Development, Integration and Implementation

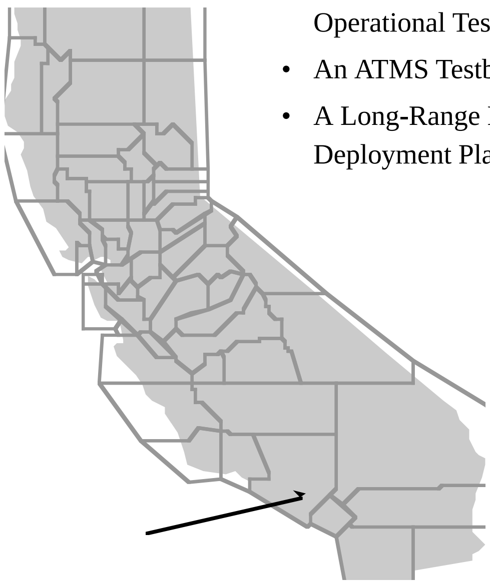
Systems Architecture and Institutional Issues - Project Highlights

A Showcase of ITS Technologies and Stakeholder Cooperation

The Southern California Priority Corridor, one of four corridors identified in the nation, is to be a showcase for the deployment of intelligent transportation systems (ITS). Southern California is a major destination for international travel and goods movement. Travelers and goods flow to and through the corridor from Asia, Mexico, Central America, South America and Europe to destinations in Southern California and the rest of the nation. It is critical, therefore, that the transportation system supports the smooth flow of people and goods through the most populated area in the state.

The four major efforts occurring in the corridor are:

- An Intermodal Transportation Management and Information System (ITMIS) Showcase Project;
- Five Smaller-scale Field Operational Tests;
- An ATMS Testbed; and,
- A Long-Range ITS Strategic Deployment Plan.



An important component of the showcase of ITS is the institutional cooperation that is necessary to accomplish these objectives. The Southern California Priority Corridor partners have begun to lay a solid foundation by establishing cooperative agreements, regional teams, and a steering committee to assure the effective execution of the four initiatives. Local participation and leadership will be emphasized in the management of this effort.

ITMIS Showcase Project

The showcase is a major effort to integrate intelligent transportation system technologies into a model intermodal transportation management system. The project will design, implement, operate and evaluate ITS user services which provide linking and optimization of multimodal transportation systems within the region. The showcase project will demonstrate an areawide interactive/integrated transportation management and information system based on real-time, computer-assisted transportation management and communications. User service will include:

- Real-time information to travelers and operators;
- Decision/management support to transportation management centers, traffic engineering/public safety departments and vehicle fleet operators (public and commercial); and,
- Information/communications network, linking transportation systems and modes which are presently uncoupled, including marine and air.

Field Operational Tests

Five Field Operations Tests have been funded by FHWA in the corridor.

- In the city of Irvine, an integrated ramp metering/adaptive signal control project will evaluate the operational effects of balancing traffic flow between I-5/I-405 and the parallel arterial streets. The project will also demonstrate the effectiveness of collaborative action on the part of transportation management agencies to optimize their strategies to improve traffic flow.
- The city of Anaheim is testing Split, Cycle, Offset Optimization Technique (SCOOT) as an adaptive signal timing control package. SCOOT automates the data collection process and then automatically optimizes traffic signal timing based on real-time traffic conditions. Video Traffic Detection System cameras will be installed and evaluated in conjunction with the SCOOT system.
- At locations throughout Orange County, a Mobile Surveillance Field Operations Test will evaluate the use of a portable detection and surveillance system for highway construction, special events, and incident locations. Specially-equipped trailers will be placed at temporary traffic congestion locations. Trailer-mounted video image detectors will use spread spectrum radio for transmission of real-time information to state and local control centers.
- State, regional and local agencies in San Diego will take advantage of the extensive call box system to increase their functionality by adding an interface to traffic management devices. These "smart" call boxes will collect traffic census data; obtain traffic counts, flows and speeds for accident detection; detect and report hazardous weather conditions; control changeable message signs, and operate roadside closed-circuit television cameras.
- The city of Los Angeles is conducting a spread spectrum radio traffic interconnect project to evaluate wireless traffic signal communications. The radios will be tested in a network of signals to determine their ability to reliably re-route communications links, their ability to work in a variety of geographies, their ability to provide for large-scale once-per-second communications, and to determine the cost-effectiveness of using this technology.

Systems Development, Integration and Implementation

Systems Architecture and Institutional Issues - Project Highlights

Testbed

The Advanced Transportation Management Systems (ATMS) Testbed is a cooperative program sponsored by Caltrans, PATH and local agencies in Orange County to enable ongoing research, testing and evaluation activities for development and operation of integrated multijurisdictional and multimodal transportation management systems. The testbed utilizes existing real-time, computer-assisted traffic and transportation management systems and PATH labs at the University of California, Irvine and California Polytechnic State University, San Luis Obispo.

The ATMS testbed is intended to:

- Provide an instrumented, multijurisdictional, multiagency transportation operations environment linked to university laboratories for real-time technologies and applications. It will enable off-line testing of products and further development of research prototypes prior to installation in the field;
- Provide a meeting ground for practitioners and researchers to try new approaches to transportation system management;
- Enable private industry to demonstrate and evaluate their prototyped technologies under real-world traffic conditions; and,
- Make available a continual testing ground for California and national ITS efforts.

Strategic Deployment Plan

Early deployment planning for intelligent transportation systems in the Priority Corridor will occur over an 18-month period. A Strategic Deployment Plan, estimated to be completed in the summer of 1997, will address the 29 user services defined by ITS America as they would apply to the needs of Southern California. The plan will identify “early starts,” as well as a 20-year plan/schedule and funding estimates for deployment of ITS elements. Public participation is an important element of the plan. To define the needs of the users of all transportation systems and modes, input will be solicited from commercial freight operators, transit operators and travelers.

Start-up activities in the corridor have already provided an exceptional opportunity to develop partnerships with stakeholders. These include MPOs, state agencies, air quality management districts, cities, counties, and transit districts. The opportunity to participate will continue to expand to include various modal operators, private industry, and others.

Stability in state funding that parallels ISTEA is essential if California is to realize the vision set before it. Currently $12.9 million in state funds is annually budgeted to leverage, in conformance with AB3096, $20 million in federal funds and $10 million in cost sharing from Caltrans' partners.

This baseline budget provides Caltrans with the minimum state funding necessary to ensure viable California economic partnerships to continue current major program initiatives in the areas of the Automated Highway Systems (AHS) Prototype; Priority Corridor Showcase; Smart Traveler Deployments (urban); Deployment Planning (urban and rural); Transportation Management Systems Testing; and, Automated Highway Construction and Maintenance.

However, a more aggressive ATS market approach could have far reaching economic benefits for California in key market areas, such as: nearer-term vehicle safety products; multimodal traffic management; advanced fleet management; and, premium traveler services packaged for new multimedia and telecommunications markets.

This market approach requires aggressive institutional issues resolution to assure integrated public/private efforts, cooperative research, development, and testing, supporting technology deployments in the public infrastructure, and standards development to accelerate commercialization. Accordingly, adoption of state policy and legislative initiatives may be required.

The resource estimates for aggressive research, development and testing of technologies on an annual basis are:

- State - $30 million;
- Federal - $20 million; and,
- Partners - $30 million.

Public infrastructure improvements/deployments are estimated at $300 to $500 million from all sources.

A strong commitment to the ATS Program will further mobility and economic opportunities for California. The program's vision will be realized primarily through strategic deployment of technologies to the public transportation infrastructure. Private sector investment and commercialization will be necessary. This holds great potential for establishing new California businesses in international markets and the creation of jobs for Californians into the 21st century.

TRANSPORTATION MANAGEMENT SYSTEMS

Multimodal Traffic Management

- *Incident Management*
- *Travel Demand Management*
- *Traffic Control*
- *Electronic Payment Services*
- *Public Travel Security*
- *Emergency Notifications and Personal Security*

Advanced Fleet Management

- *Automated Roadside Safety Inspection*
- *Public Transportation Management*
- *Commercial Fleet Management*
- *Commercial Vehicle Preclearance*
- *Commercial Vehicle Administrative Processes*
- *Emergency Vehicle Management*

Intermodal Facilities

Transportation Management Systems is a package of technologies that enables the integration of freeway and surface arterial operations so that travel corridors and areas can be efficiently managed and will enhance communications for commercial vehicle operations.

The milestones, scope of services, activities and specific project highlights for Transportation Management Systems are discussed on the following pages.

Transportation Management Systems

1993	1994	1995	1996	1997	1998
California Specification - AVI		Electronic Toll Collection Deployment	Advanced Transit Fleet Management Demonstration	Real-Time Adaptive Traffic Control Demonstration	Multimodal TMC Demonstration
		"Smart Corridor" Demonstration	National ITS System Architecture Selected	HOV Route Guidance Test	Public Travel Security Demonstration
		ATMS Test Bed Established	Prototype HOV - TMC Interaction	Emergency Notification (Mayday) Demonstration	
		H.E.L.P. Implementation	Guidelines for Navigable Map Database		
1993	1994	1995	1996	1997	1998

Transportation Management Systems

Multimodal Traffic Management — Scope

Transportation Management Systems - Multimodal applications can be defined in these user services terms:

- **Incident Management**

Helps officials quickly identify incidents and implement a formalized set of procedures to minimize impacts on the transportation system.

Incident management will also help schedule or forecast predicted incidents to minimize impacts. Predicted incidents include road construction and maintenance, road closures, and certain severe weather conditions. Verification and response activities apply to both predicted and unpredicted incidents once they occur. Incident management will support the development and implementation of appropriate response actions including changing traffic control. In some cases, where incident management is closely integrated with other user services, automation will improve the speed and effectiveness of responses.

- **Travel Demand Management**

Supports policies and regulations such as the 1990 Clean Air Act.

The act requires employers with over 100 employees in designated areas of severe or extreme ozone pollution to implement a travel demand management program. The concept includes:

- Reducing the number of single-occupancy vehicles commuting to work;
- Increasing the use of high-occupancy vehicles for selected user group markets;
- Mitigating the impact of highly polluting vehicles; and,
- Providing a wide array of mobility options.

Government and private industry can use travel demand management dynamically, depending on congestion and pollution conditions in a given area, at a given time. Applications include enforcing HOV lane use, parking control, and road access pricing and prioritization schemes.

- **Traffic Control**

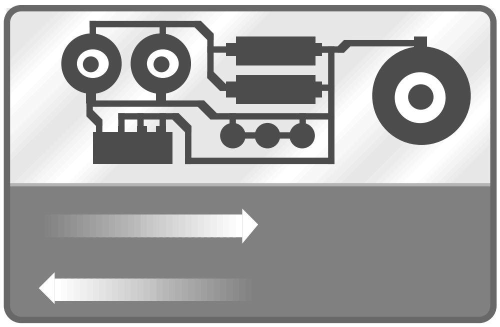
Manages the movement of traffic on the transportation system.

Traffic control services optimize and coordinate freeway and signalized street operations with public transportation operations to balance demand with capacity within the transportation system. In its more advanced forms, preferred treatment can be given to high-occupancy vehicles through traffic signal and adaptive traffic control.

- **Electronic Payment Services**

  Allows travelers to pay for transportation services with electronic cards or tags.

The goal is to provide travelers with a common electronic payment medium for all transportation modes and functions including tolls, transit fares, and parking. A common service fee and payment structure, employing multi-use SmartCards, could integrate all modes of transportation, including roadway pricing options.



- **Emergency Notification and Personal Security**

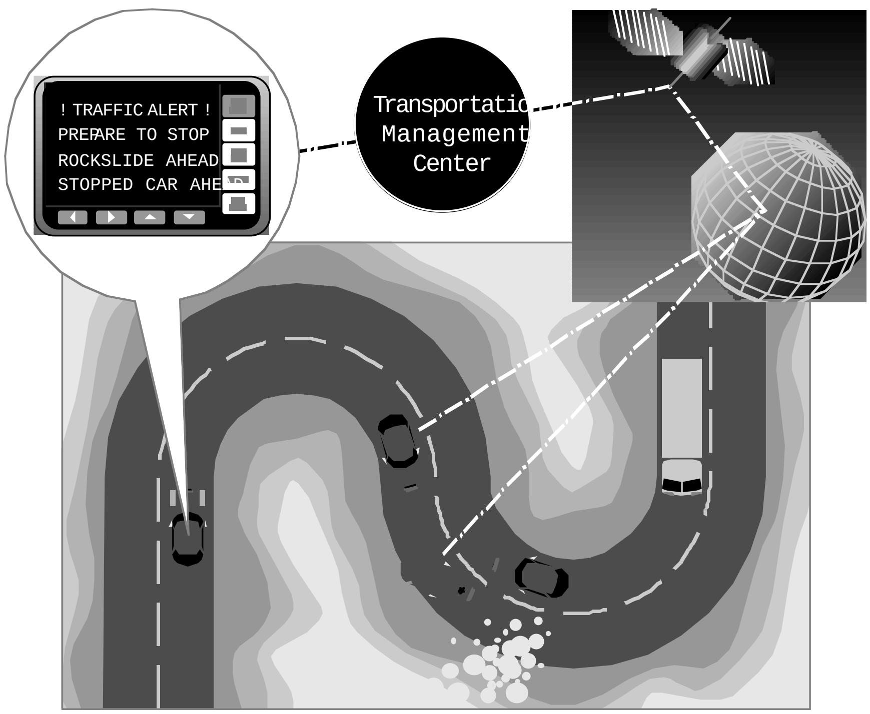
  Provides immediate notification of an incident and immediate request for assistance.

Emergency notification and personal security includes two capabilities: driver/personal security, and automatic collision notification. Driver and personal security capabilities provide for user initiated distress signals for incidents like mechanical breakdowns and carjackings. The message will include vehicle location and the receiver will send an acknowledgment signal back to the user. Automatic collision notification identifies a collision and automatically sends information regarding location, nature, and severity to emergency personnel.

- **Public Travel Security**

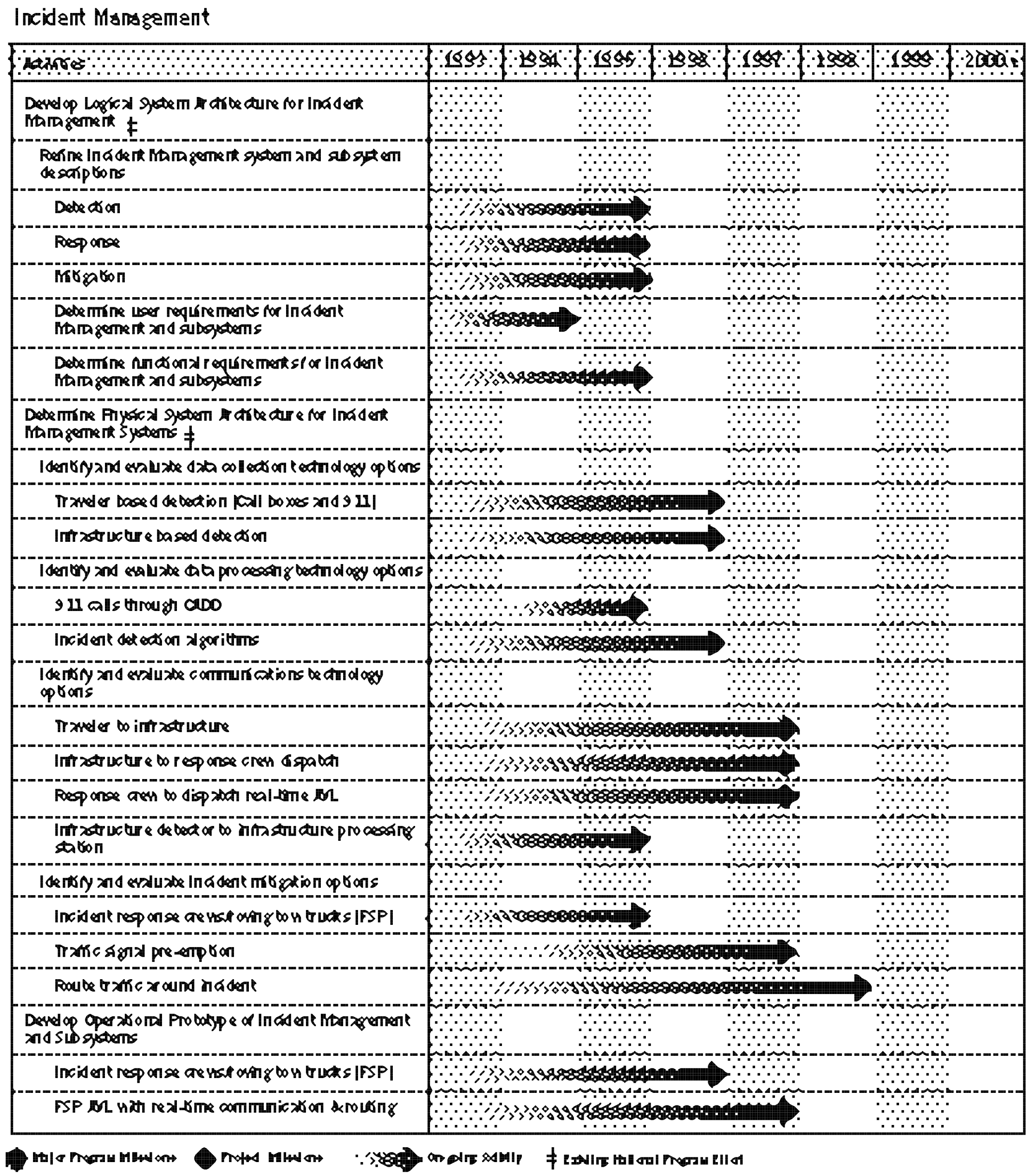
  Creates a secure environment for public transportation patrons and operators.

The automobile separates its passengers from the surrounding environment and provides a perception of security and personal control. Public transportation users must trust control of their environment to the operator and local police.



Transportation Management Systems

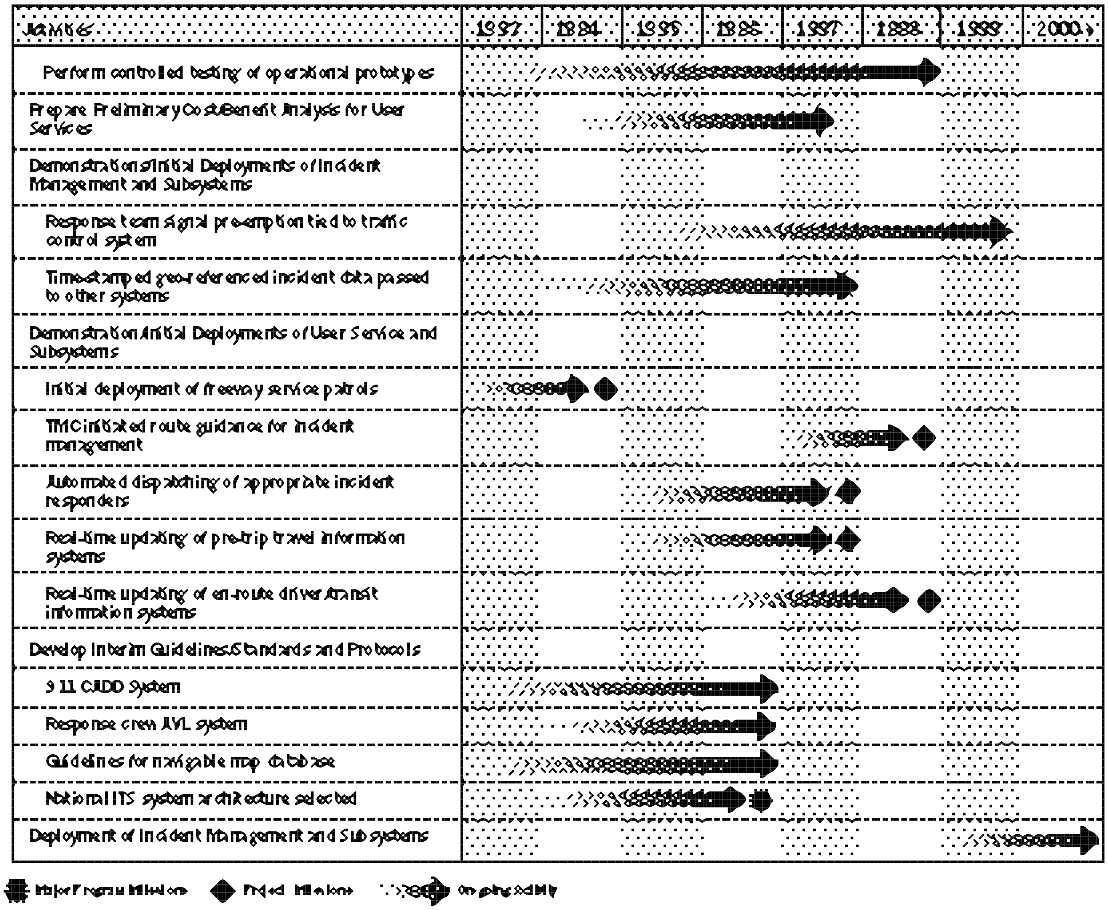
Multimodal Traffic Management — Activity Charts



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

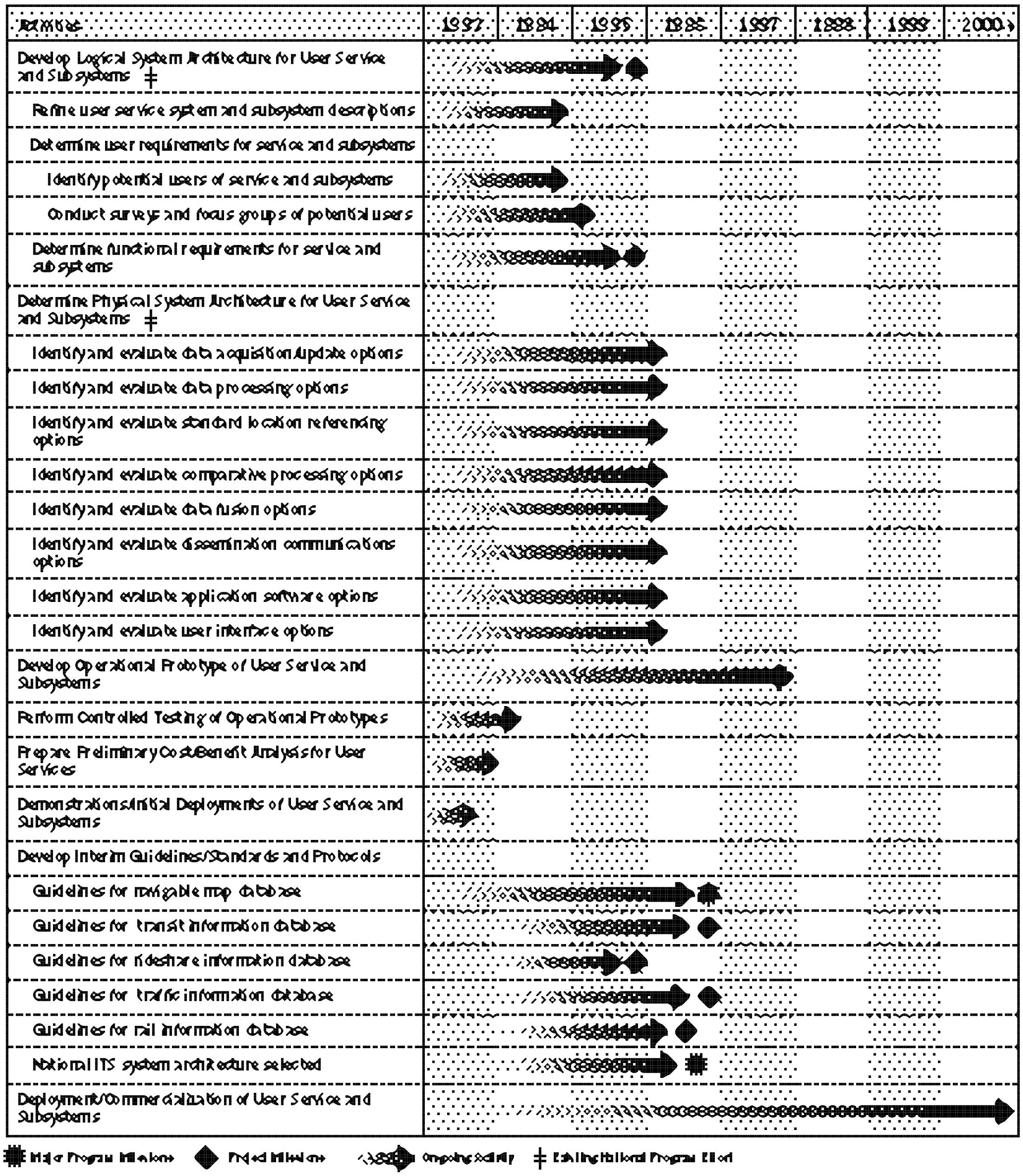
Incident Management contd



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

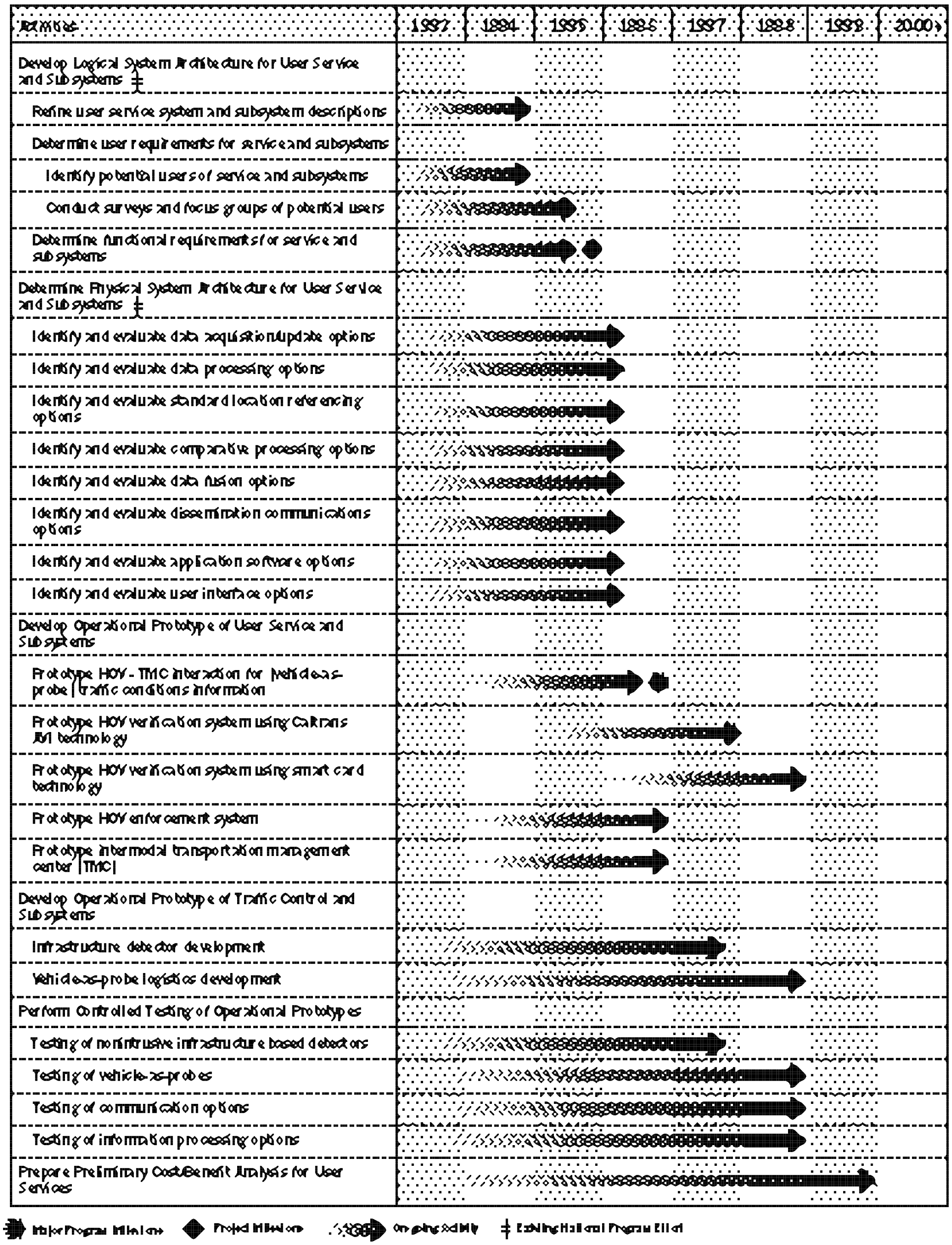
Travel Demand Management



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

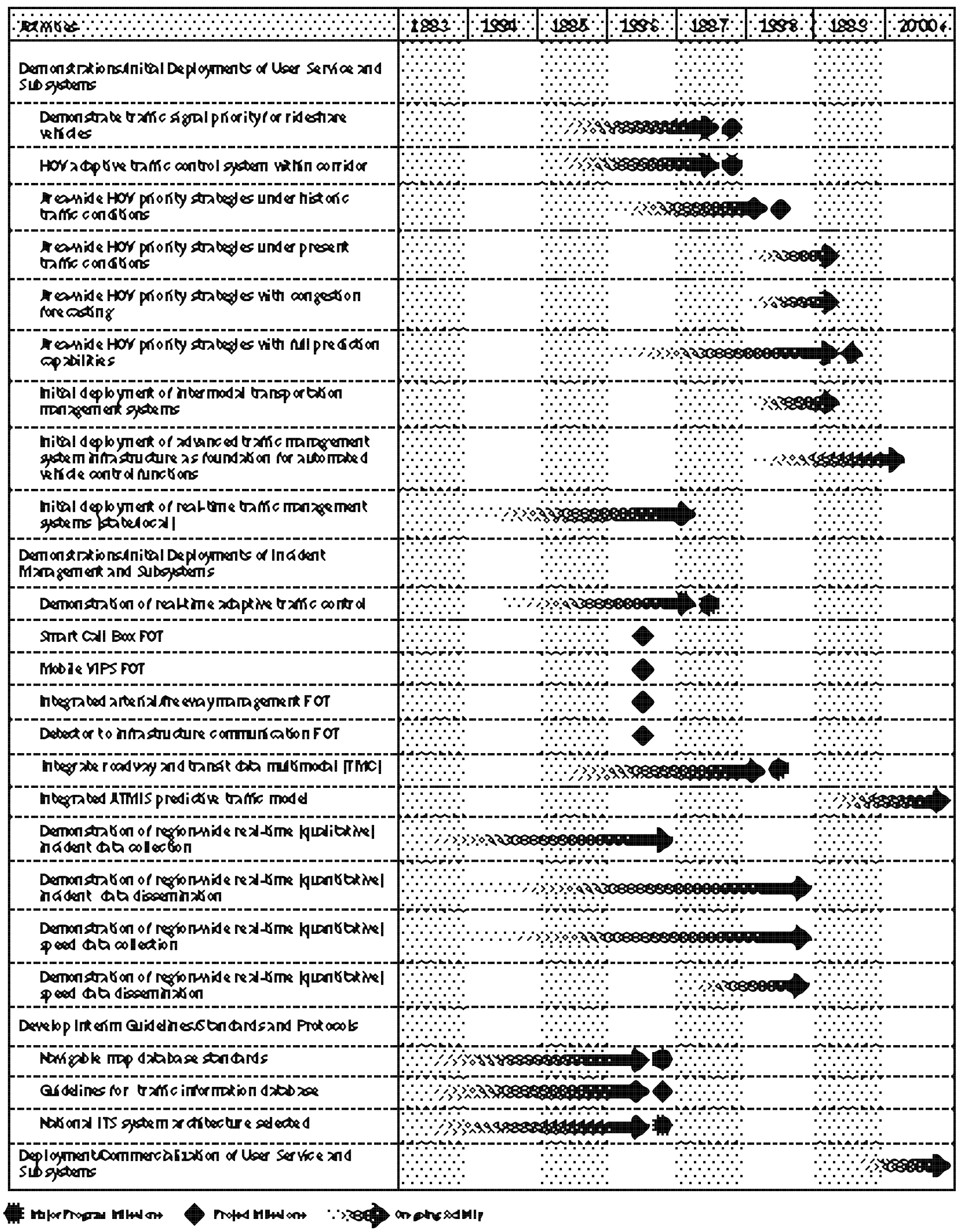
Traffic Control



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

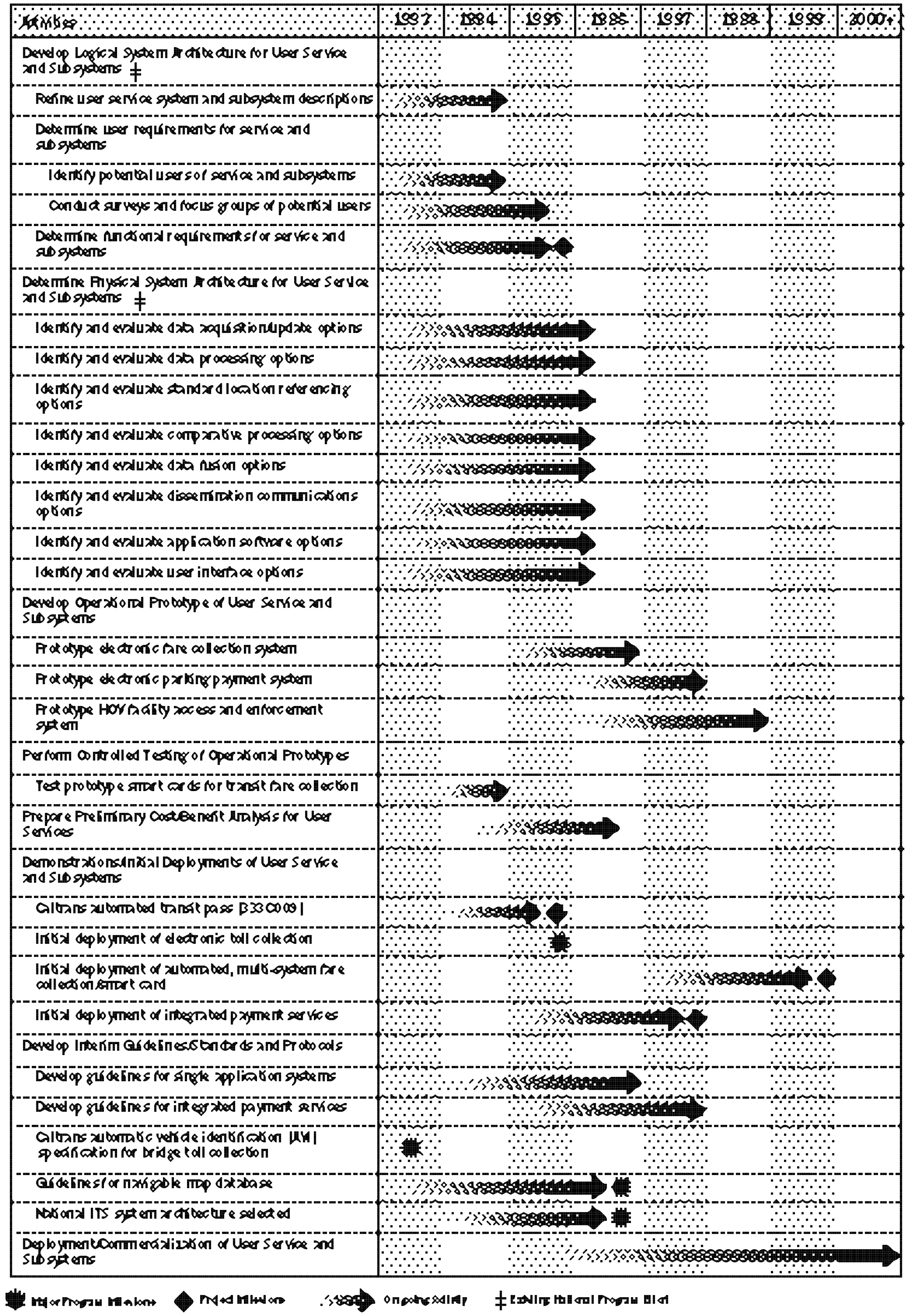
Traffic Control cont'd



Transportation Management Systems

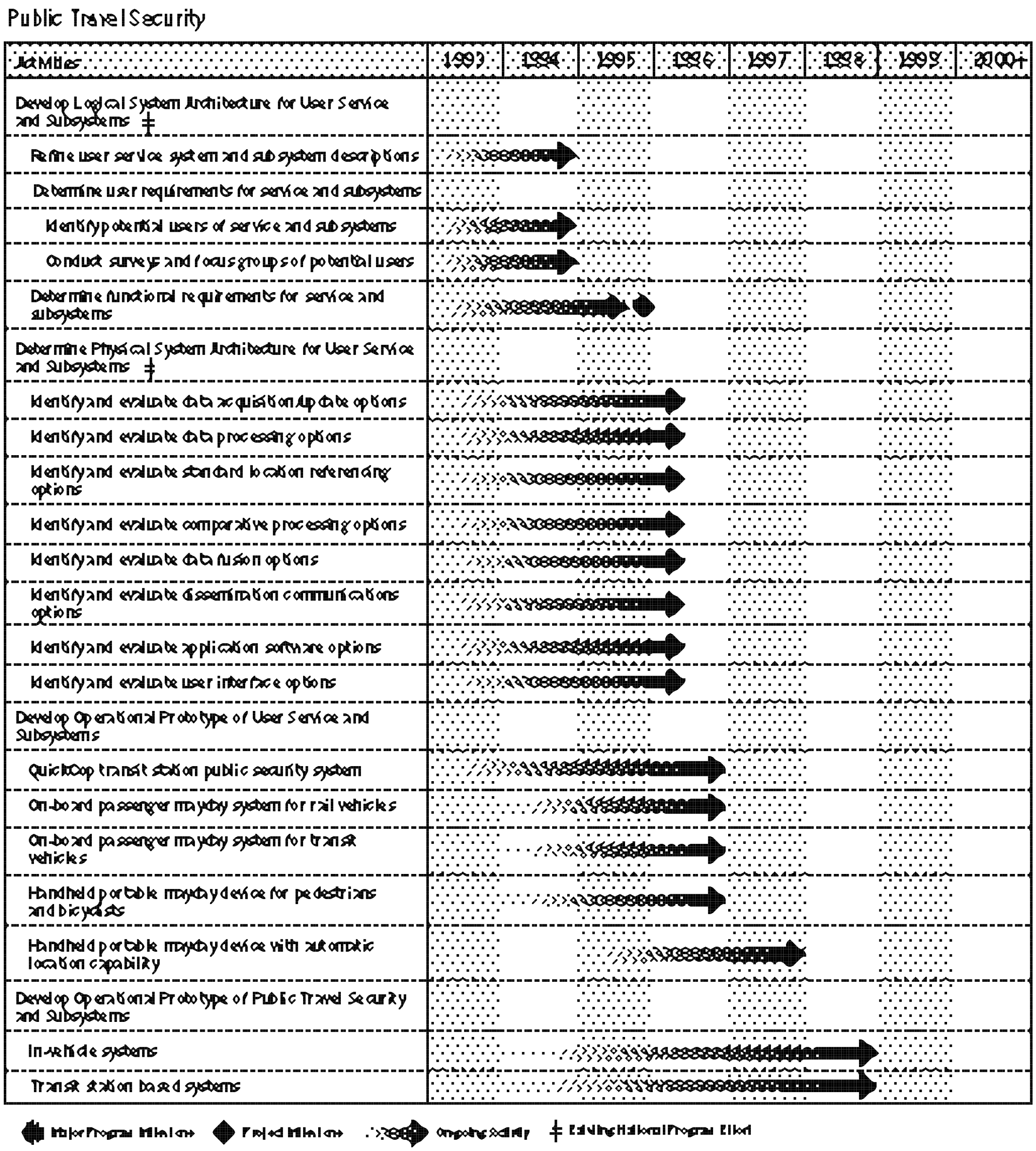
Multimodal Traffic Management — Activity Charts

Electronic Payment



Transportation Management Systems

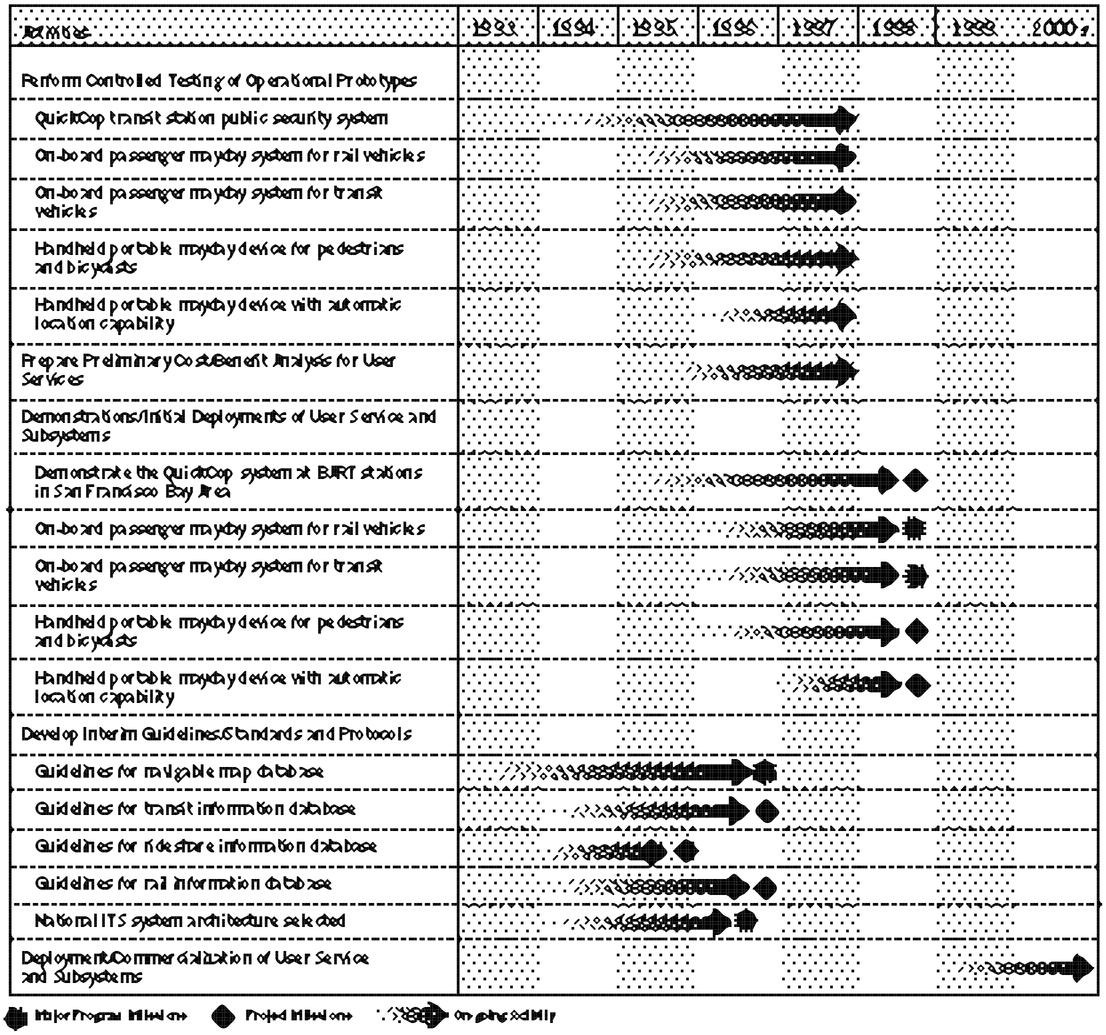
Multimodal Traffic Management — Activity Charts



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

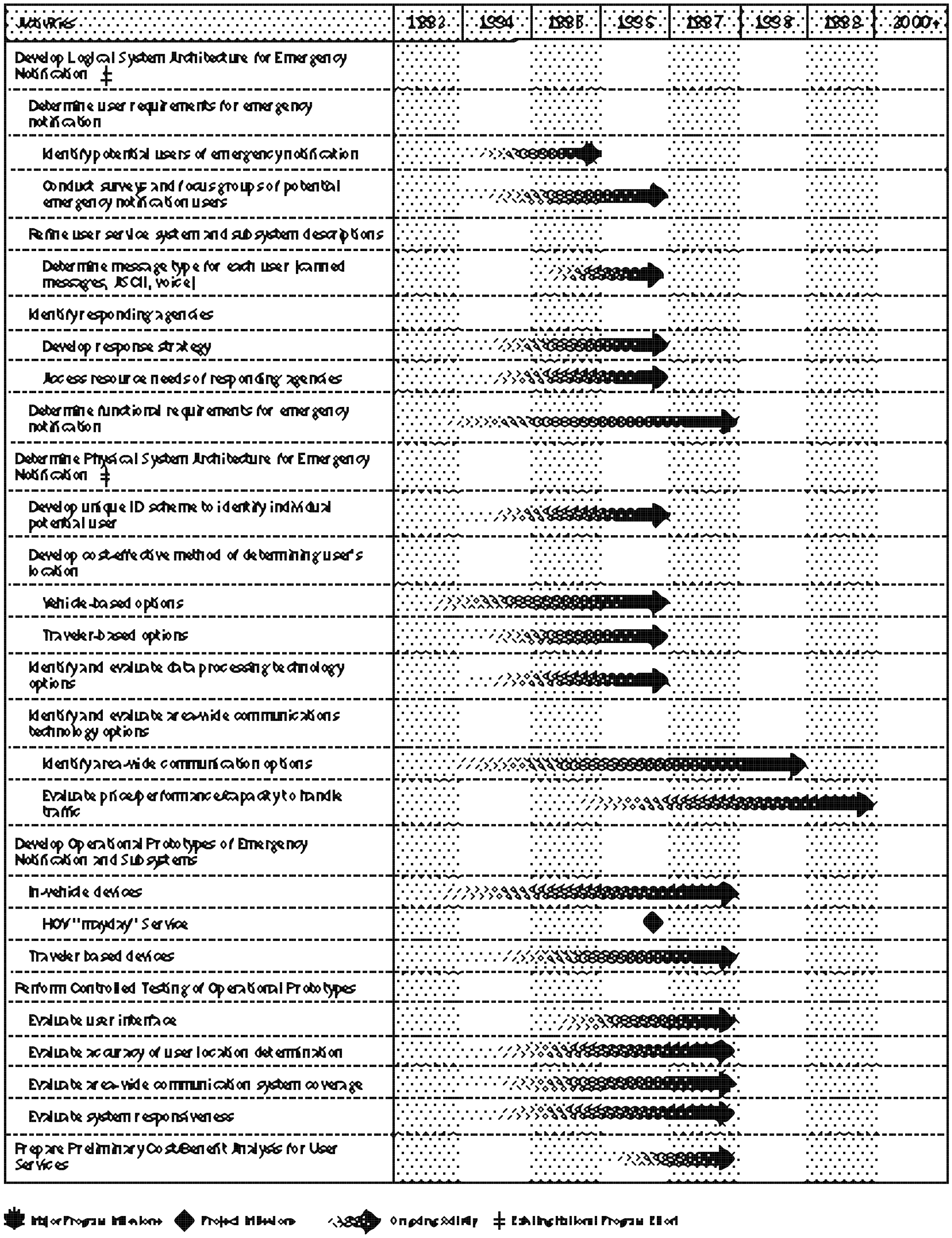
Public Travel Security contd



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

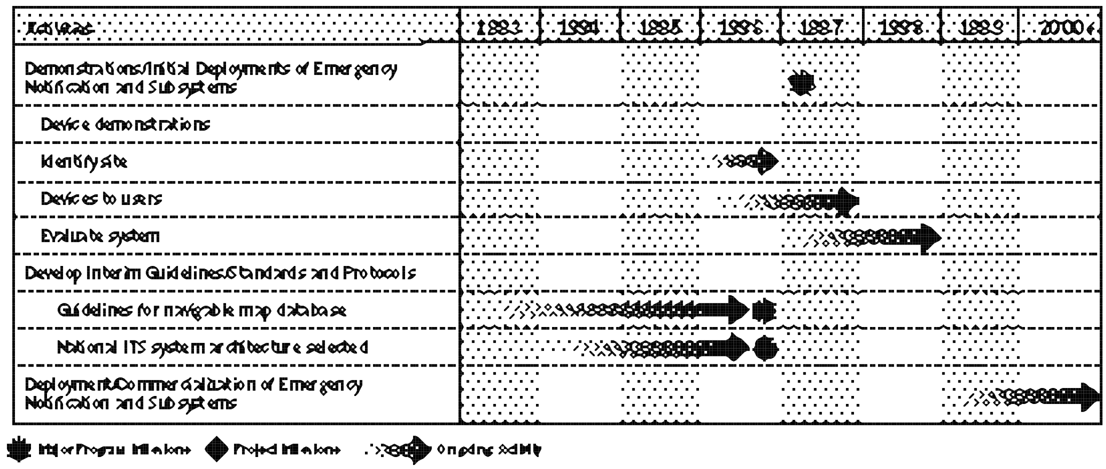
Emergency Notification and Personal Security



Transportation Management Systems

Multimodal Traffic Management — Activity Charts

Emergency Notification and Personal Security contd



Transportation Management Systems

Multimodal Traffic Management — Project Highlights

Transportation Management Systems/Centers

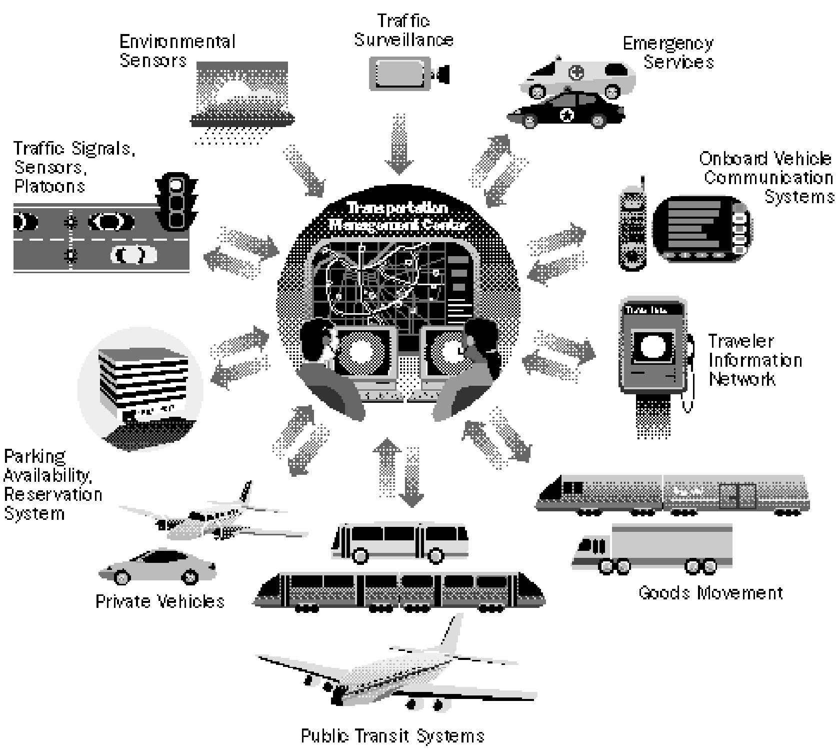
A Transportation Management Center (TMC) simulator is in place at California Polytechnic State University, in San Luis Obispo

For the past 20 years, Caltrans has been utilizing state-of-the-art technology to manage over 750 miles of southern California freeways. Ramp metering, now commonplace in many areas of the state, was first implemented in southern California in 1970. Plans, which included a Traffic Operations Center (TOC), for traffic mitigation for the 1984 Olympics, were developed starting in 1976 and made history in the field of traffic management. The importance of traffic surveillance in managing traffic was clearly demonstrated during this monumental undertaking.

The Los Angeles TOC, the first in the state, is still its most advanced and has become a blueprint for those being developed in major metropolitan areas throughout California. Formerly TOCs, they are now called Transportation Management Centers (TMCs) because they encompass so much more than just traffic operations. TMCs are jointly developed and staffed by the California Highway Patrol and Caltrans—the first partnership of its kind in the country.

The next logical step in this progression is the development of an Intermodal Transportation Management and Information System (ITMIS) (see page 192). An ITMIS is a building block for the transportation system. There are two major approaches for its design. In Orange County (Caltrans District 12), efforts are focused on developing a distributed system of centers linked by communications and data. The new TMC in San Diego (opened in July 1995) includes the California Highway Patrol and Caltrans Maintenance and Operations Communications Center all in one location. In the future, the center will include transit and commercial fleet operators and other local transportation providers.

Caltrans has already established a TMC simulator at California Polytechnic State University in San Luis Obispo to help train traffic managers and TMC operators in optimal TMS strategies. Computer-based expert systems will also help TMC operators handle accidents, hazardous material spills and other incidents and emergencies, and would enable automation of routing management functions now performed by humans. Fiber optics and satellite communications can provide the broad bandwidth necessary for video image and high volume data transmission from field to control center, and among control centers (state and local).



Advanced Fleet Management applications can be defined in the following user services terms:

- **Automated Roadside Safety Inspection**

  Focuses on improving safety in all commercial vehicle operations.

Automated roadside safety inspections include roadside access to records of carriers, vehicles, and driver safety. Such convenient and thorough access will be helpful in determining what should be checked and how to maximize resources spent on safety. Advanced diagnostics will efficiently check critical vehicle systems and driver fitness for duty.

These capabilities will provide safer, more efficient, and more accurate inspection of commercial vehicles. Enforcement personnel will have access to important safety information and records for all commercial vehicles. Automated inspections could provide pass/fail assessments of critical systems, as well as expected life projections. Carriers could also apply rapid automated safety checks in their preventive maintenance programs.

- **Public Transportation Management**

  Automates operations, planning, and management functions.

Computer analysis of real-time vehicle and facility status will improve operations and maintenance. The analysis identifies deviations from schedule and provides potential solutions to dispatchers and drivers. Integrating this capability with traffic control services can help maintain transportation schedules and assure transfer connections in intermodal transportation. Automated planning and scheduling capabilities will use archived data for analyzing trends. Information regarding passenger loading, bus running times, and mileage accumulated can be applied to route and service improvement. Automatically recording and verifying performed tasks will help with personnel management.

- **Commercial Fleet Management**

  Provides the same capabilities and performs the same functions in the commercial goods movement area as in public transportation management.

Technological advances in public transportation management are directly applicable to commercial vehicles providing goods movement. Caltrans is heavily involved in promoting advanced technologies that facilitate improved fleet operations. Currently, there is a research project to determine the most appropriate role for government in furthering fleet management services and their applications for improving intermodal transfers.

Caltrans and the CHP will continue development efforts in these areas and will collaborate with companies that transport goods in developing new transportation systems.

Transportation Management Systems

Advanced Fleet Management — Scope

- **Commercial Vehicle Preclearance**

Facilitates domestic and international border preclearance, minimizing stops.

This user service provides for point to point non-stop operation while satisfying regulatory requirements such as the issuance of licenses and permits, record keeping, tax collections, and inspection and weighing across multiple jurisdictions, including domestic and international borders.

- **Commercial Vehicle Administrative Processes**

Provides electronic purchasing of credentials and automated mileage and fuel reporting.

Electronically purchasing credentials gives carriers the option to select and purchase annual and temporary credentials via computer link with the appropriate jurisdictions. Automatic deductions from the carrier's account with a jurisdiction will also streamline processing. There is a potential for synergy with commercial vehicle preclearance services.

For registration and auditing purposes, carriers maintain accurate mileage and vehicle information for every trip. Automating this procedure with the commercial vehicle administrative processes service enables participating interstate carriers to electronically capture mileage, fuel purchase, trip, and vehicle data by state. Electronic logs eliminate the need to manually prepare quarterly reports for fuel taxes and annual reports for registration.

- **Emergency Vehicle Management**

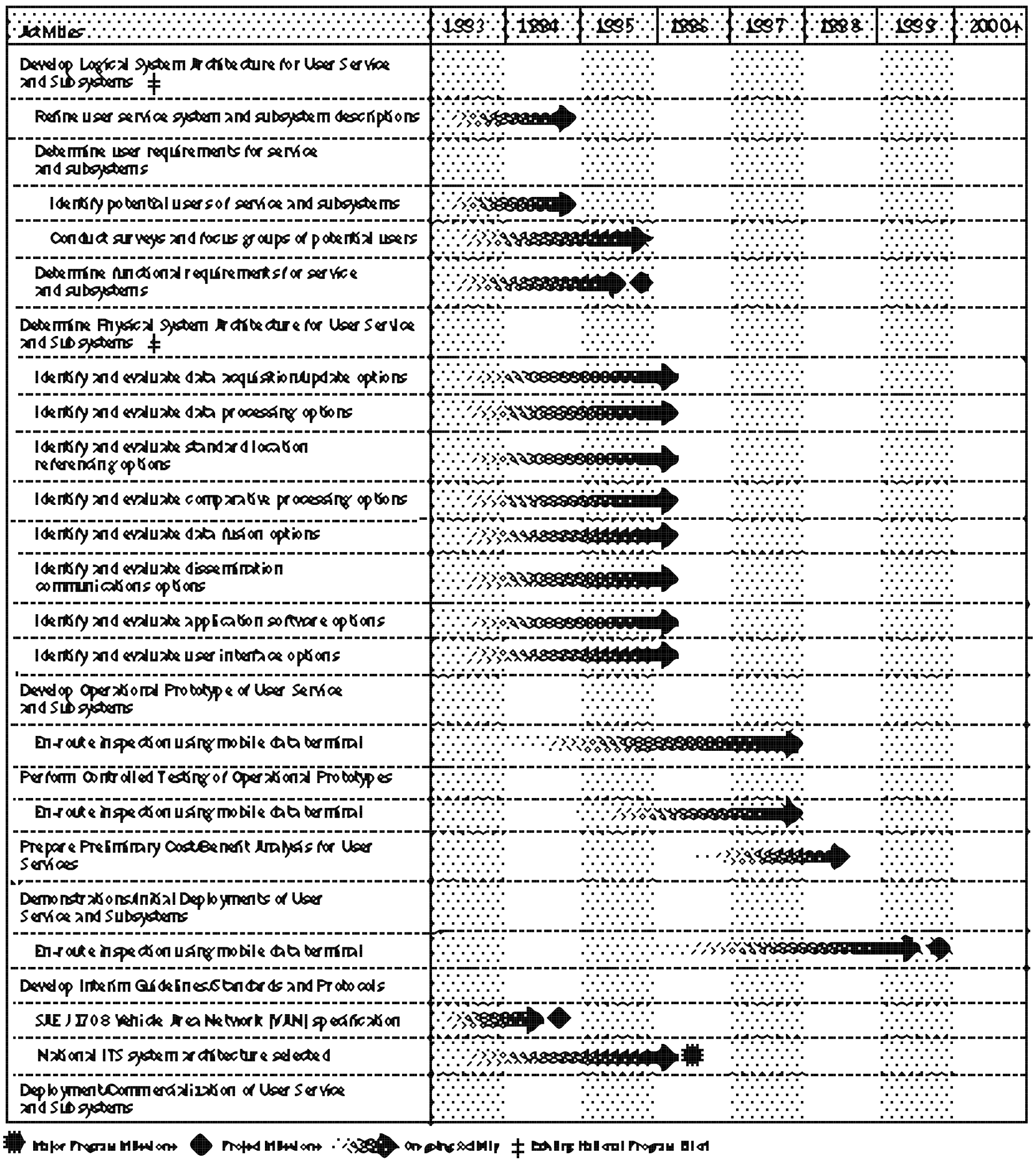
Reduces the time it takes to respond to incident notification and arrive on the scene.

This user service is closely related to the hazardous material incident management user service, within the commercial vehicle operations category. Primary users include police, fire and medical units. The service comprises three capabilities: fleet management, route guidance, and signal priority. Fleet management will improve the display of emergency vehicle locations and help dispatchers efficiently send the unit that can most quickly reach an incident site. Route guidance directs emergency vehicles; signal priority clears traffic signals on an emergency vehicle's route.

Transportation Management Systems

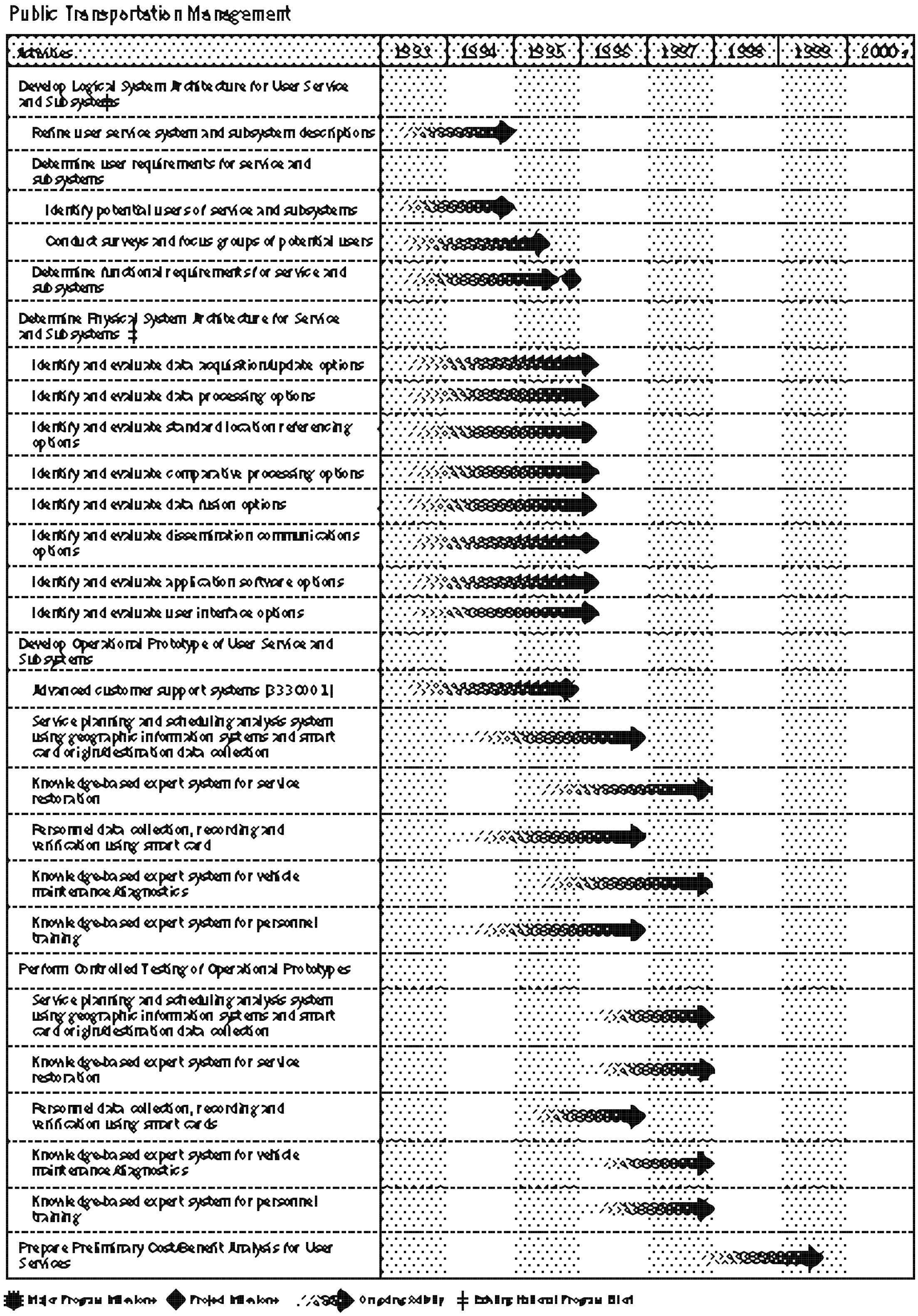
Advanced Fleet Management — Activity Charts

Automated Roadside Safety Inspection



Transportation Management Systems

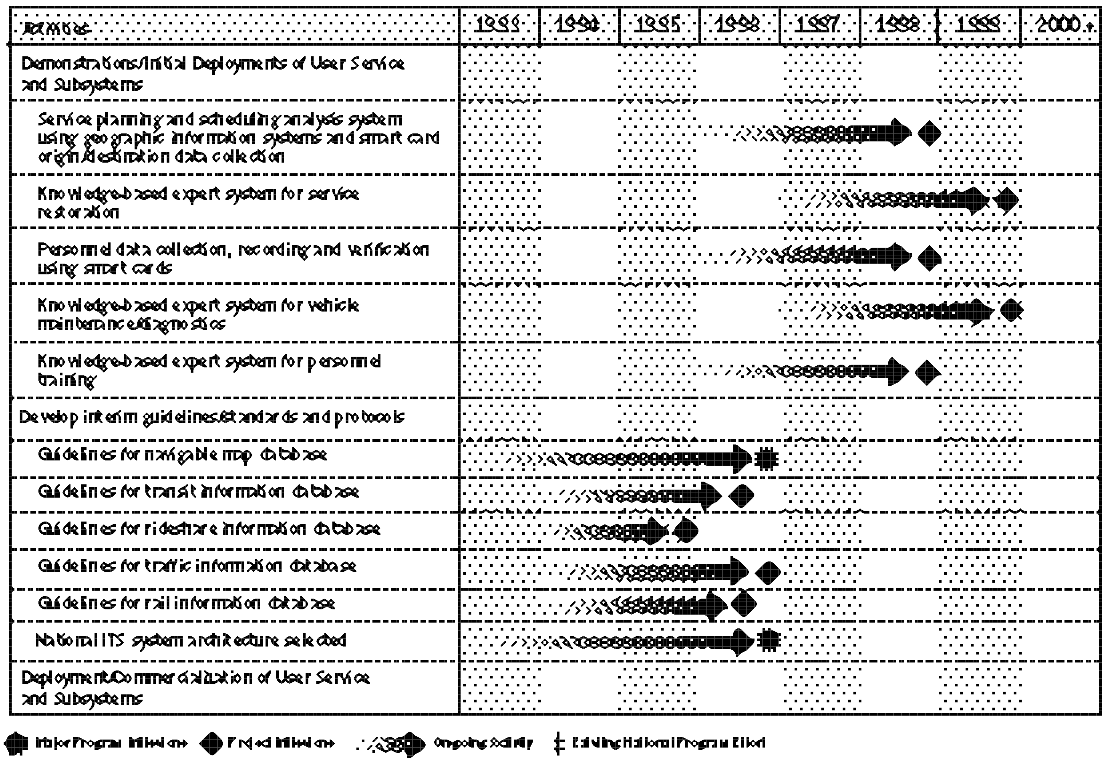
Advanced Fleet Management — Activity Charts



Transportation Management Systems

Advanced Fleet Management — Activity Charts

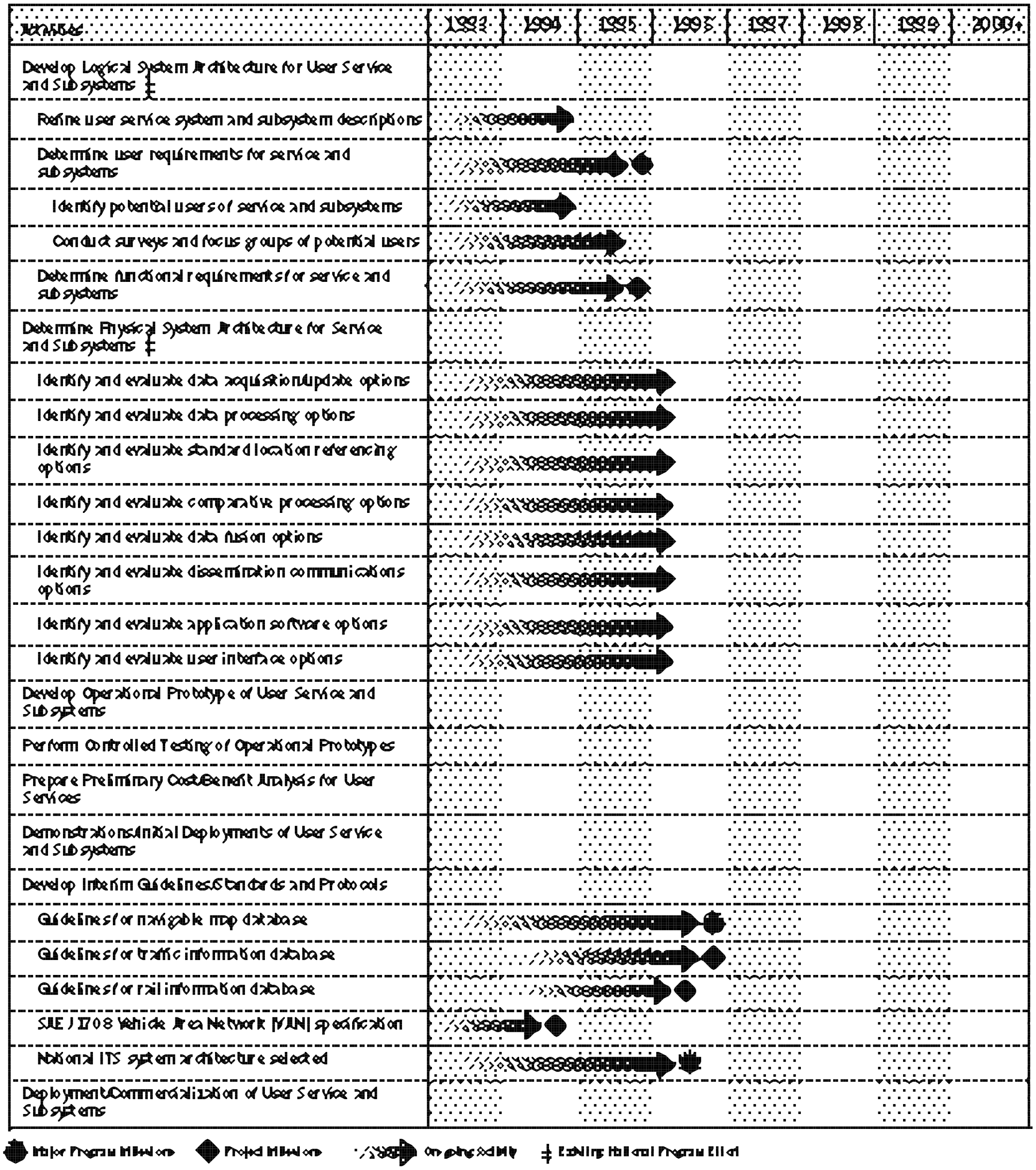
Public Transportation Management cont'd



Transportation Management Systems

Advanced Fleet Management — Activity Charts

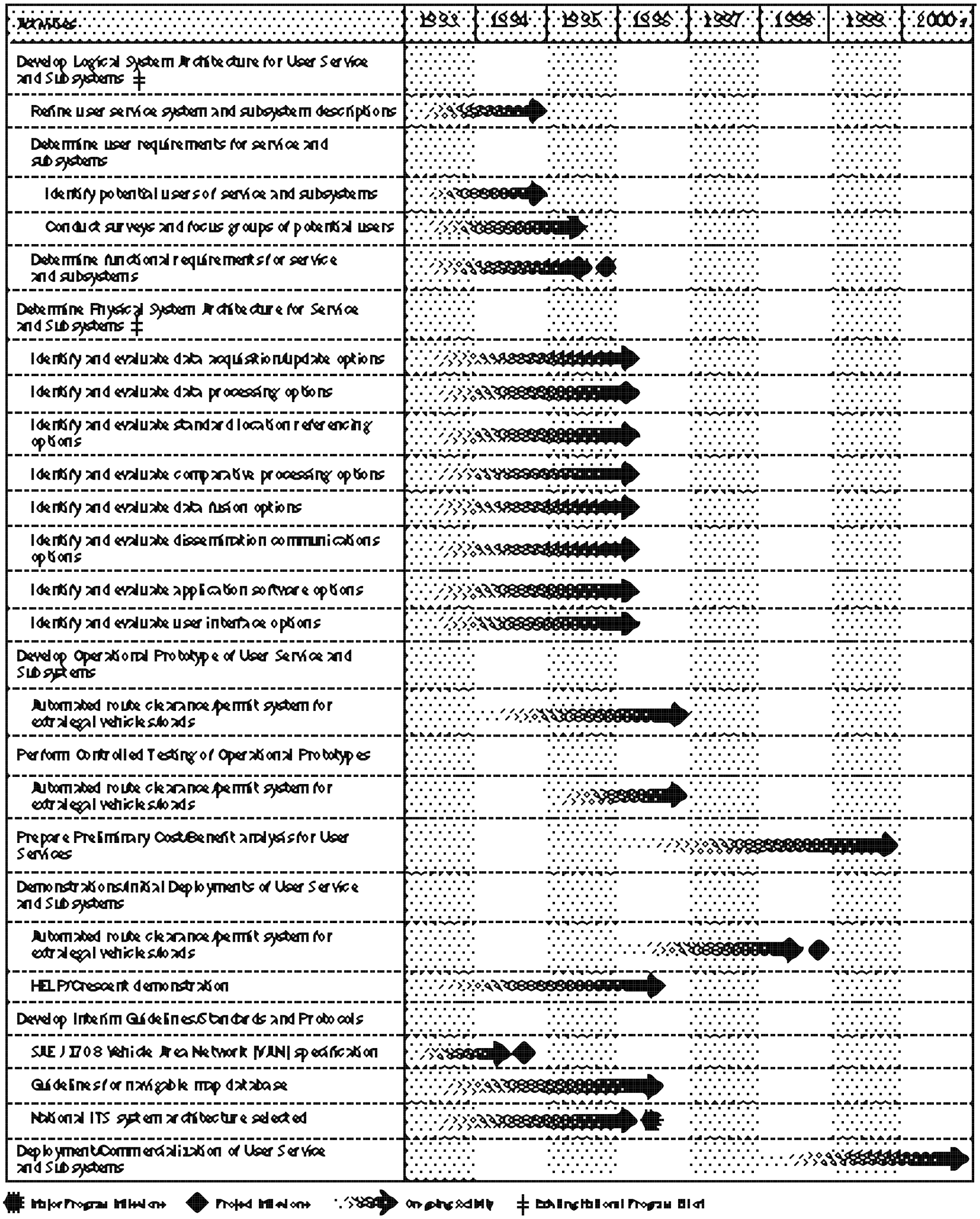
Commercial Fleet Management



Transportation Management Systems

Advanced Fleet Management — Activity Charts

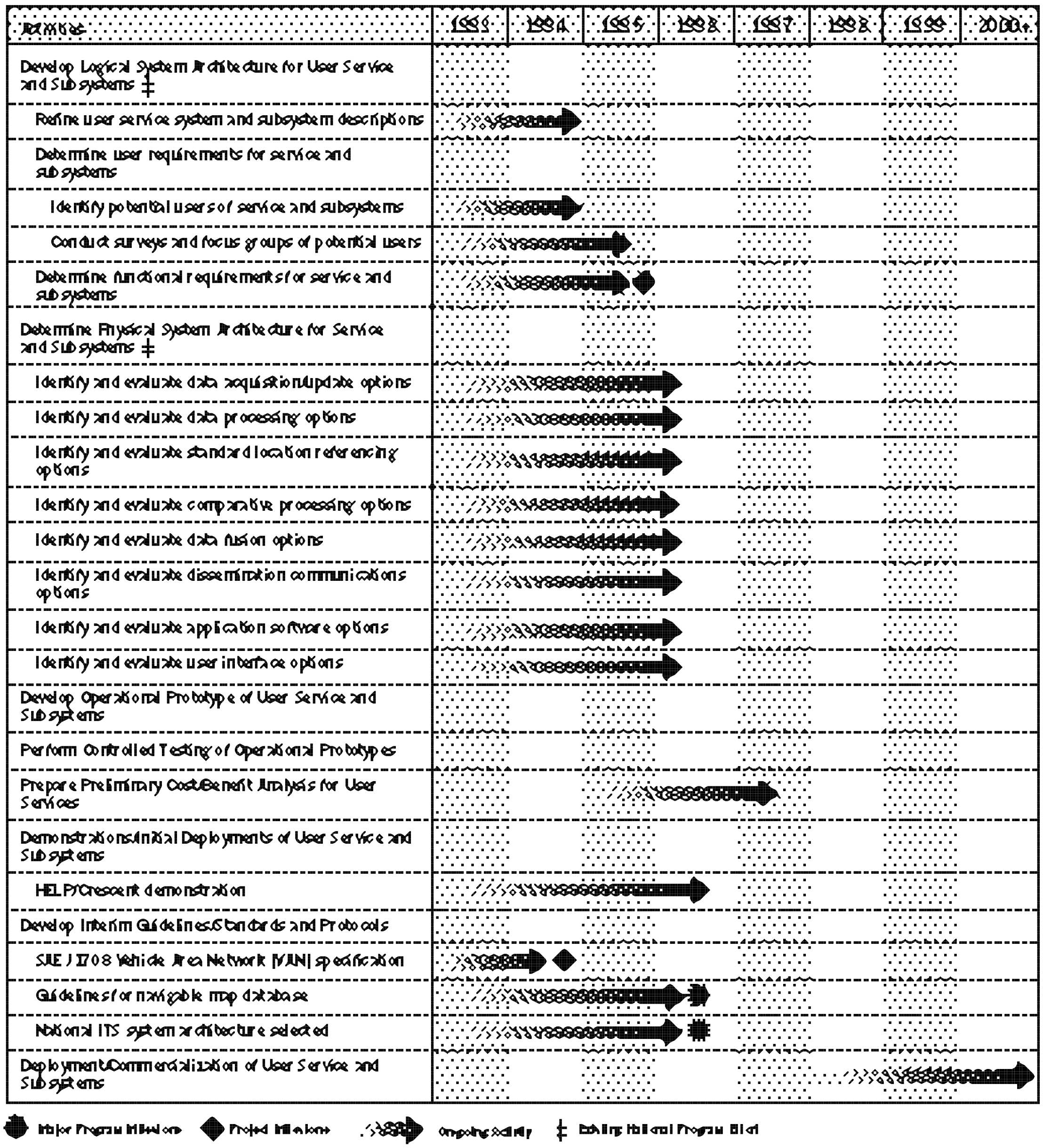
Commercial Vehicle Preclearance



Transportation Management Systems

Advanced Fleet Management — Activity Charts

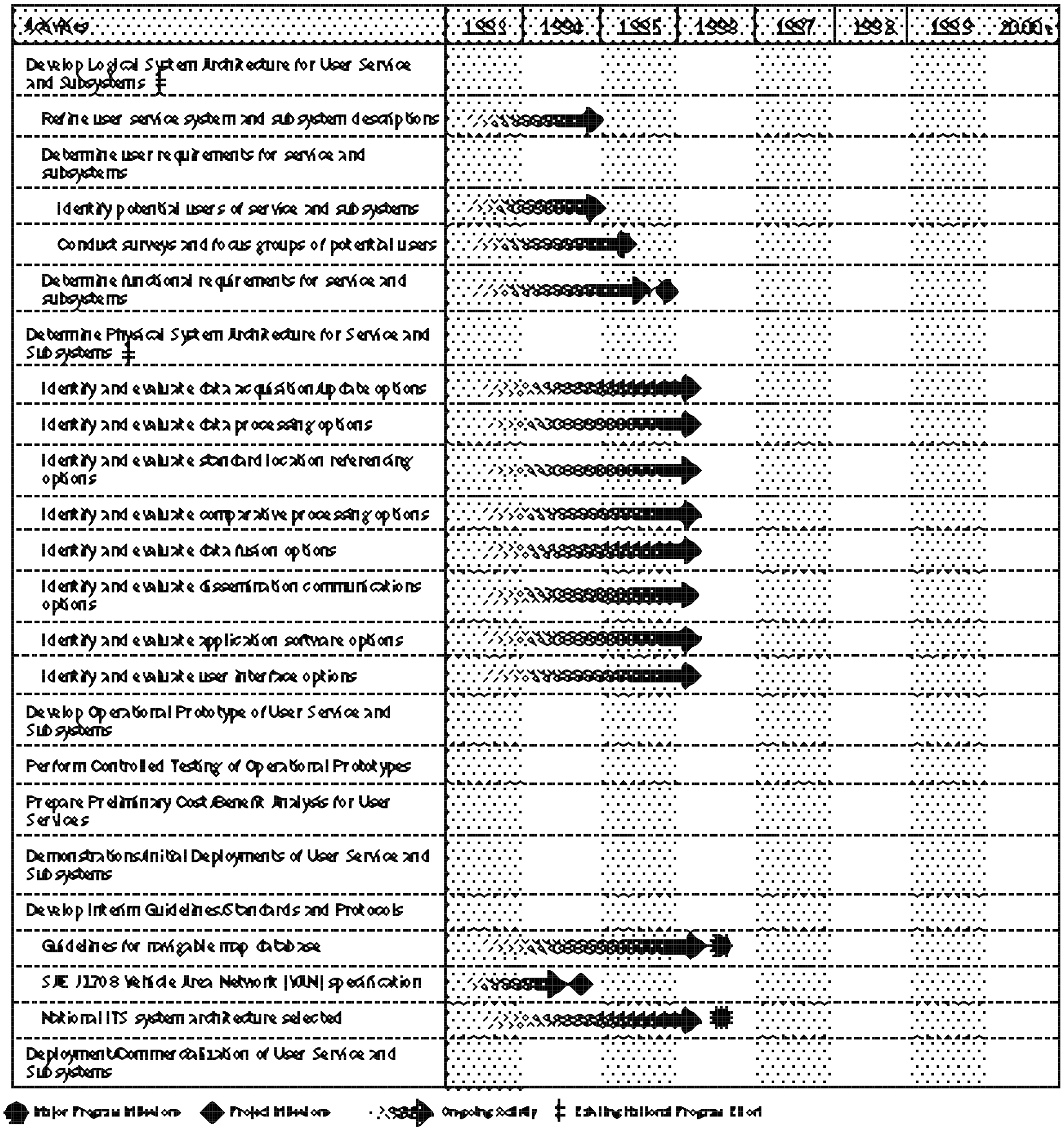
Commercial Vehicle Administration Processes



Transportation Management Systems

Advanced Fleet Management — Activity Charts

Emergency Vehicle Management

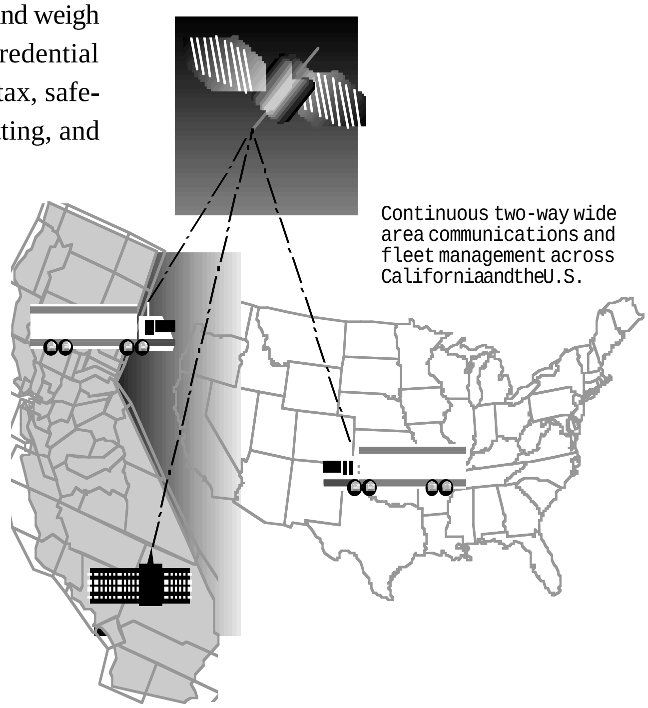


Transportation Management Systems

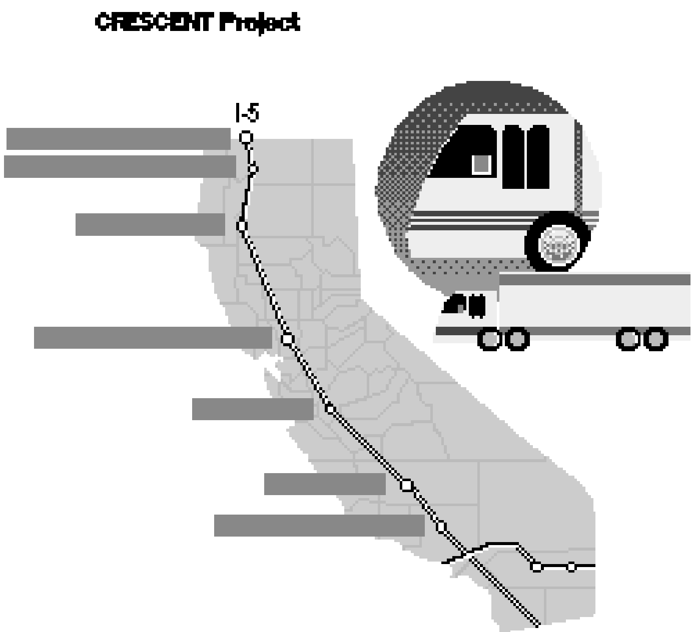
Advanced Fleet Management — Project Highlights

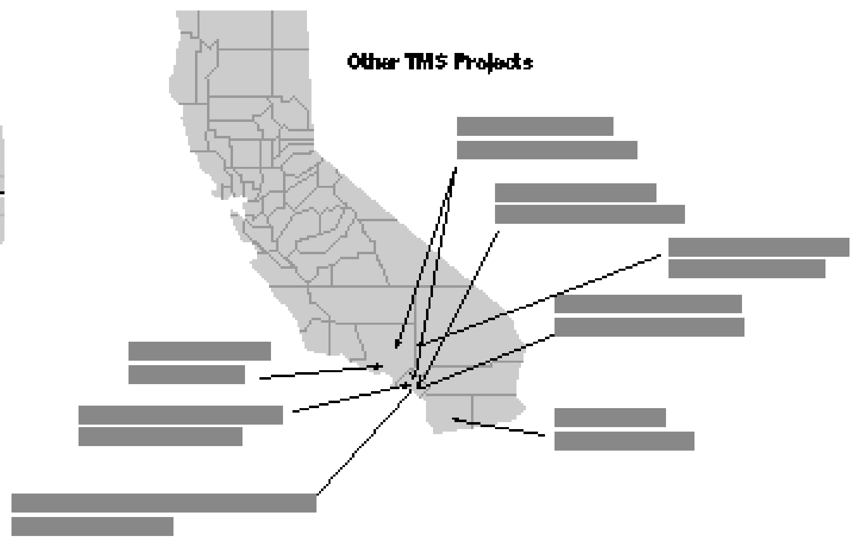
H.E.L.P. Project

The Heavy Vehicle Electronic License Plate Program (H.E.L.P.) is a multistate, multinational research effort to design and test an integrated heavy vehicle monitoring system. Using Automatic Vehicle Identification (AVI), Automatic Vehicle Classification (AVC) and Weigh-In-Motion (WIM) technology, the H.E.L.P. project permits trucks to bypass ports of entry and weigh stations by providing automated credential verifications of registrations, fuel tax, safety, oversize and overweight permitting, and a central data base for fleet information and management. It is expected to be completed in 1996, when it will include preclearance sites in ten states. H.E.L.P. facilities are being installed in California on I-5 and I-10, and are proposed in several other areas, including I-880 in the San Francisco Bay Area.



Continuous two-way wide area communications and fleet management across California and the U.S.





Connectivity of the various modes for people and goods movement can be enhanced through terminal facilities where travelers can transfer from one mode to the other with a minimum of discomfort or where goods can be efficiently moved from one mode to another.

Approaches that will assist with intermodal connectivity are:

- Bringing bus stops, with easily understood signage, close to the disembarkation areas of planes and trains;
- Bringing trains into air terminals to facilitate transfers of passengers and baggage from one mode to the other;
- Establishing safe bicycle storage facilities at transfer points for cyclists to transfer to buses, trains or planes;
- Designating routes on the National Highway System to be "Freight Corridors" to establish design, construction, and maintenance priorities; and, to reduce congestion; and,
- Working at the national level, with public and private organizations, to design programs and secure funding for the advancement of intermodalism as an equal partner in the transportation fabric of California and the United States.

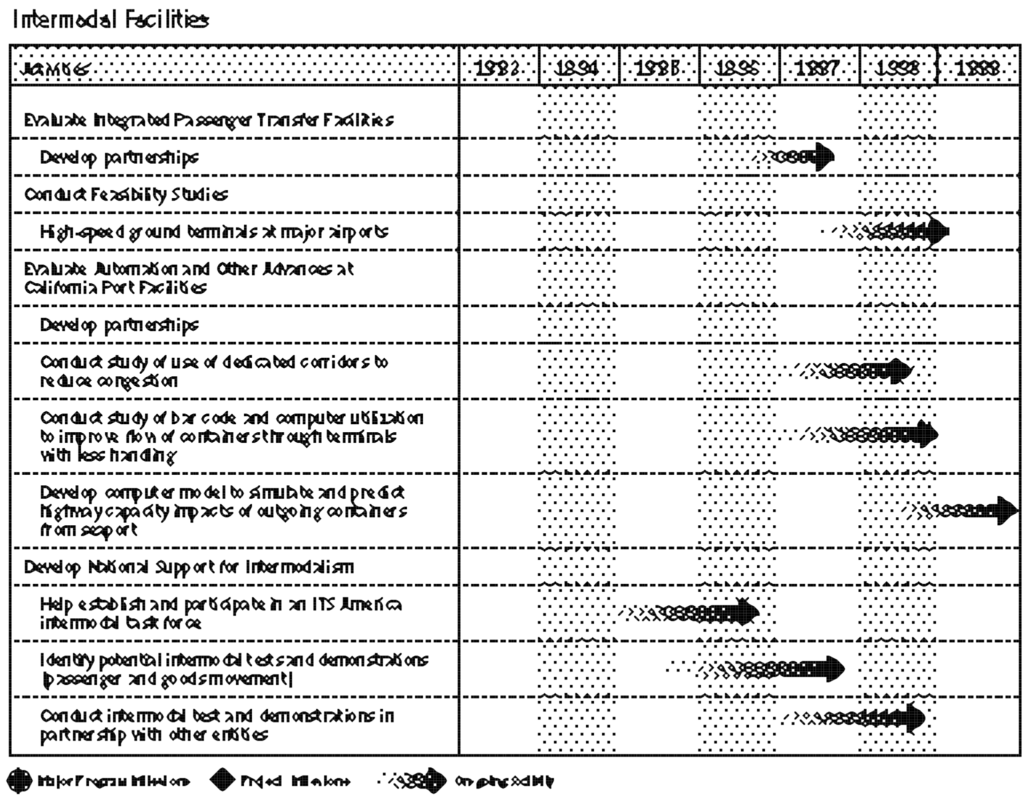
Work to redesign, improve the technology and automate California ports and terminals will be required to realize the full benefits of the ATS highway, rail, waterway and airway infrastructure. Application of ATS at the transfer point ("interfaces") will increase the efficiency and effectiveness of intermodalism for both passengers and goods.

California's extensive port (air/waterway) and waterway system could benefit greatly from the same ATS technologies and coordination being applied to other ground systems. Among the benefits would be improved ground access and maximized efficiency of the "landbridge" across the state and the North American continent (movement of goods inland from seaports and across the continental United States). Examples of applicable technologies are:

- Ship collision avoidance, such as in low visibility areas using digital maps, global positioning systems, computers and wireless communications;
- Vessel routing, tracking and scheduling;
- Vessel fitness monitoring;
- Automated cargo monitoring; and,
- Next-generation port/intermodal transfer facilities.

Transportation Management Systems

Intermodal Facilities — Activity Charts



In March 1994, ITS America's Coordinating Council established a new task force to investigate including other modes of transportation (rail, air, sea) into an integrated, effective, intermodal transportation system. Caltrans was involved in an Intermodalism Conference late in 1994, to discuss research, development, and demonstration agendas; new initiatives; and, the future direction of "Intermodalism."

Application of information and communication technologies to the interfaces (e.g., terminals) of modal exchange will increase efficiencies, resulting in lower costs and improved safety. This scenario would be especially true in the goods movement area when coupled with management system and logistics planning. With respect to passenger systems, improvement at the interfaces will also increase the attractiveness of using public transportation.

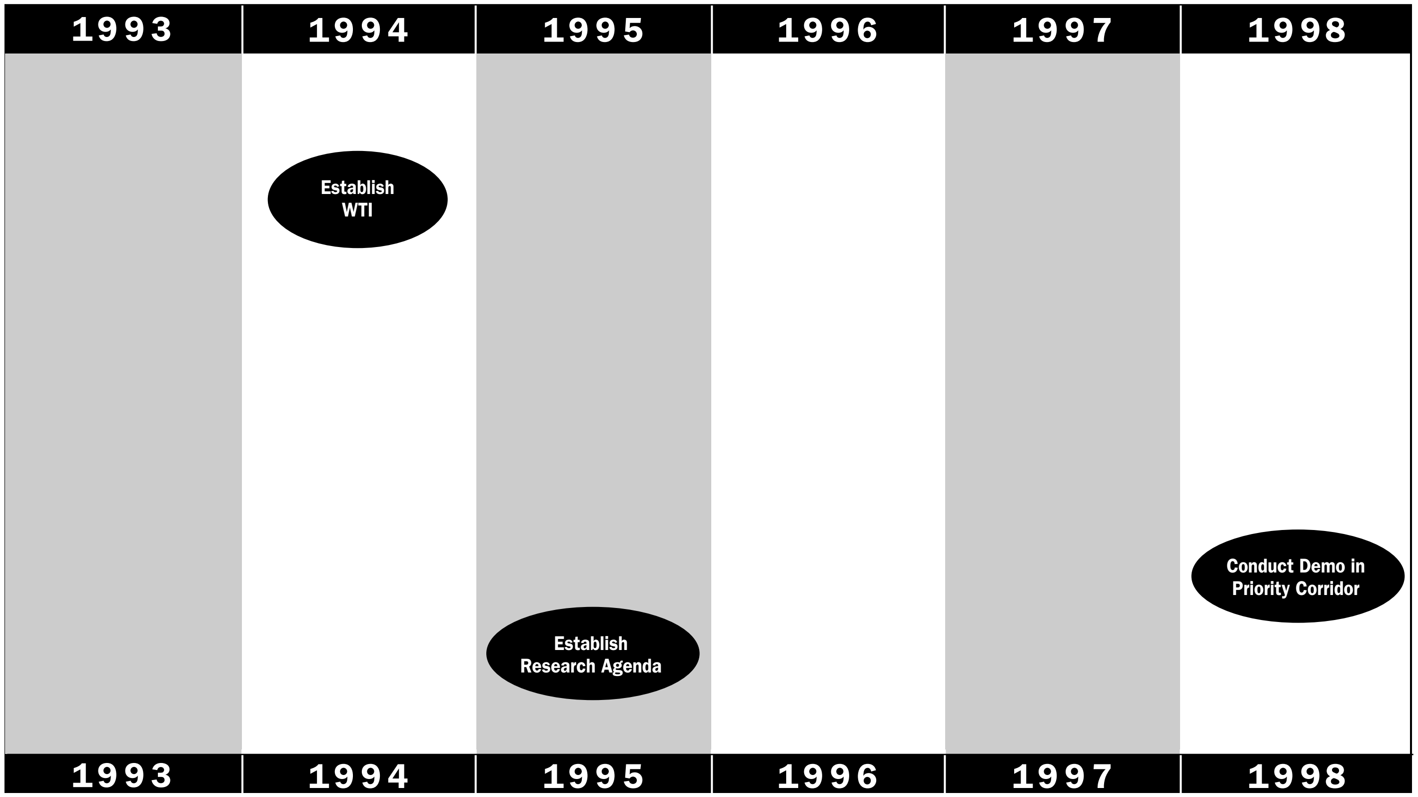
Projects being sponsored to encourage intermodal transportation usage by the public will include "off-airport terminals" construction, operation and evaluation to provide congestion relief at airports; studies and recommendations to extend rail facilities into or closer to air terminals to encourage use of alternate modes of transportation; and, studies to determine ways to lessen the impact of port side operations that affect truck usage of adjacent roads and highways.

RURAL

The rural transportation program focuses on the transportation concerns of rural California to assure the appropriate application of advanced transportation technologies to rural transportation problems.

The milestones, scope of services, activities and project highlights for Rural Transportation are discussed on the following pages.

Rural Transportation



Rural Transportation

Scope

Increased interest in rural transportation issues in the new technology/intelligent transportation systems arena is a fairly recent development. Because federal, state and local officials have been overwhelmed by the problems plaguing urban transportation, such as traffic congestion, and related air quality, noise and energy issues, little time, or resources have been devoted to rural transportation issues.

Two-lane rural highways are the backbone of the rural transportation network. These roads carry local traffic, as well as commercial vehicles, transit vehicles, school buses, and recreation and commuter traffic. Additionally, there is a system of multi-lane divided highways that serve metropolitan centers and traverse rural areas. Like urban transportation, rural transportation is also concerned with air quality control and energy conservation. While the primary focus of urban transportation may be traffic congestion, the primary focus of rural transportation technology is safety.

In 1992, the Caltrans New Technology and Research Program embarked on a research study, the “Program for Advancing Rural Transportation Technology” (PARTT). The purpose of PARTT is to focus proper attention on the transportation concerns of rural California and to assure the appropriate application of advanced transportation technology to rural transportation problems.

Directly attributed to this research study are the following successful results:

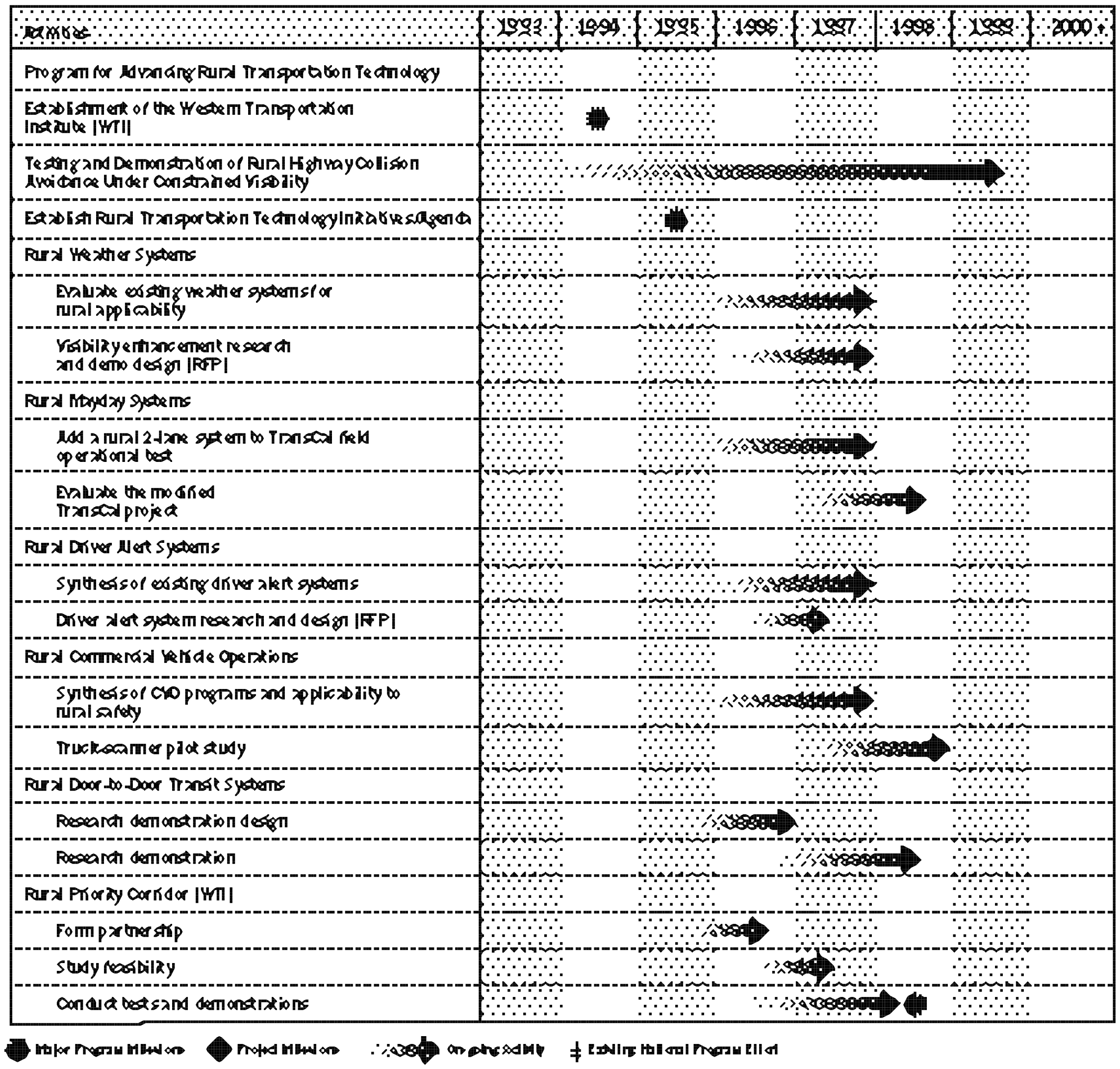
- The first national discussion on advanced rural transportation technology in the second draft of the “ITS America Strategic Plan” (January 1992);
- Establishment of an ITS America Committee to deal specifically with rural transportation technology concerns (ITS America Advanced Rural Transportation Committee, April 1992);
- The first rural transportation technology conference sponsored by Caltrans (Redding, California, September 1992); and,
- The Western Transportation Institute (WTI) established in 1994.

In addition, with ITS America, the WTI and other partners, Caltrans will help establish a formal rural technology research agenda.

Rural Transportation

Activity Charts

Rural Transportation



Rural Transportation

Project Highlights

The Western Transportation Institute — A Western Center for Rural Transportation Excellence

The Western Transportation Institute (WTI) was established in 1994, to pursue research and education in Intelligent Transportation Systems (ITS) and other rural transportation matters. WTI maintains close ties with other ITS programs nationally, including PATH.

WTI is also affiliated with many national ITS programs and organizations including the NAHSC, the National ITS System Architecture Program and ITS America. WTI, with participation from government, industry and academia, is currently working to establish a national ITS rural priority corridor for demonstration and deployment of promising rural transportation technology.

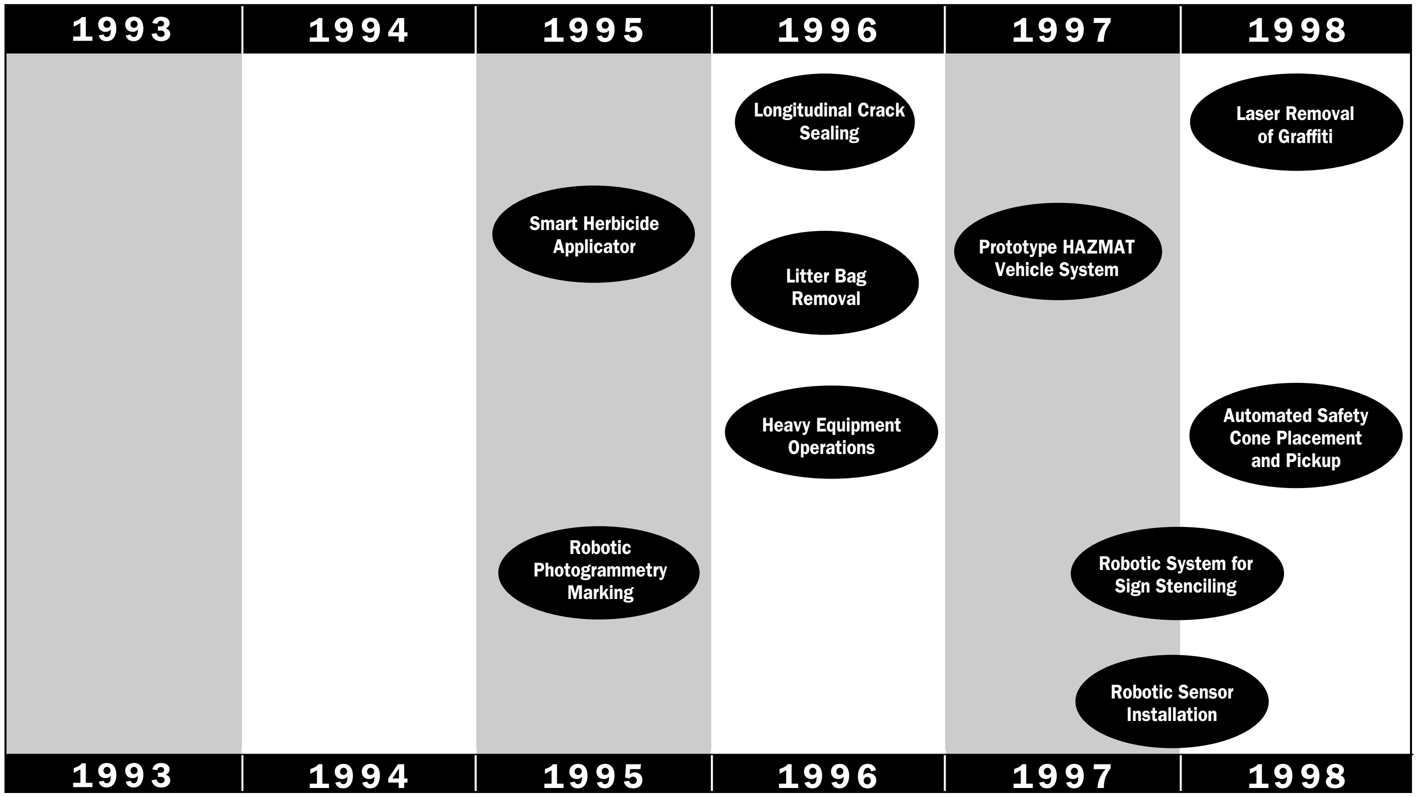
INFRASTRUCTURE CONSTRUCTION AND MAINTENANCE

- *Roadway Maintenance and Construction Technology*
- *Roadside Maintenance and Construction Technology*
- *Structure Maintenance and Construction Technology*
- *Workzone Safety Enhancements*
- *ITS/AHS Related Infrastructure Maintenance and Construction*

Infrastructure Construction and Maintenance is a program that employs technological developments, such as automation and robotics, to develop products and processes that improve the efficiency and safety of traditional highway construction and maintenance operations.

The milestones, scope of services, activities and specific project highlights for Infrastructure Construction and Maintenance are discussed on the following pages.

Infrastructure Construction/Maintenance



Infrastructure Construction & Maintenance

Scope

Current efforts by the Advanced Highway Maintenance and Construction Technology (AHMCT) Center include the development of technologies such as external sensing systems, manipulation systems, control and coordination systems, communication systems, material storage and retrieval systems, mobility systems, and human-machine interfaces. These technologies are critical to the development of automated or robotic equipment intended for transportation maintenance and construction.

The jointly staffed University of California, Davis/Caltrans AHMCT Center has developed expertise in these areas; has an understanding of current and emerging robotic and automation technology and has specifically researched future trends in technology applicable to automation of construction and maintenance tasks.

- **Roadway Maintenance and Construction Technology**

Of prime importance to Caltrans is the effective maintenance of road surfaces and pavement delineations in the form of lane striping, pavement markers and pavement and roadside signage. Efforts are underway to introduce automation and robotic technology to conventionally slow, labor intensive and potentially unsafe operations. Examples of activities under investigation include: sealing pavement cracks; painting pavement markings, including survey premarks; and, placing raised pavement markers on the pavement at prevailing speeds. These technological advances will eliminate the exposure of maintenance personnel to moving vehicles and have the potential to transform a static lane closure into a moving operation.

- **Roadside Maintenance and Construction Technology**

Caltrans is responsible for maintaining the roadside right-of-way, including landscape management, refuse and graffiti cleanup, and removal of hazardous materials. Landscape maintenance efforts are designed to limit employee exposure to the dangers of moving vehicles while performing landscape maintenance operations. Research is also aimed at substantially reducing water and herbicide usage and developing landscape vegetation suited to reduced maintenance and watering. Innovations in the areas of litter pickup equipment, remote landscape management systems, graffiti removal and prevention, and rapid and remote hazardous material spill identification and remediation are being researched. These developments will ultimately reduce employee exposure to highly toxic materials and reduce the time necessary for lane closures occurring during landscape maintenance operations.

- **Structure Maintenance and Construction Technology**

The development of methods and equipment for rapid and remote inspection of bridge components and other structures is critical to maintaining the safe condition of a deteriorating transportation infrastructure. The nation’s large inventory of aging elevated structures mandates frequent and detailed inspections using equipment of increasing sophistication. Efforts in this area focus on the development of products that will allow remote inspection of structural facilities, while reducing human risk and improving efficiency.

- **Workzone Safety Enhancement**

A wide variety of devices and processes has been developed to enhance the safety of field workers, including such products as hard hats, highly visible garments, safety cones, equipment backup signaling, and lane closure procedures. These and many other products and procedures have been adopted by the construction industry with life-saving success. Products continue to be developed at a rapid pace, as the desire to improve workzone safety continues. Recently, many products, such as workzone intrusion warning systems, vehicle sensors to prevent equipment or equipment/human collisions, and garment sensors used to alert workers of the approach of heavy equipment, have become sophisticated through the advent of the computer and sensor revolution. While research in other areas is directed towards eliminating the necessity for workers to be exposed on the roadway, the mission of workzone safety research at the AHMCT Center is to substantially increase the safety of workers both on and off the roadway.

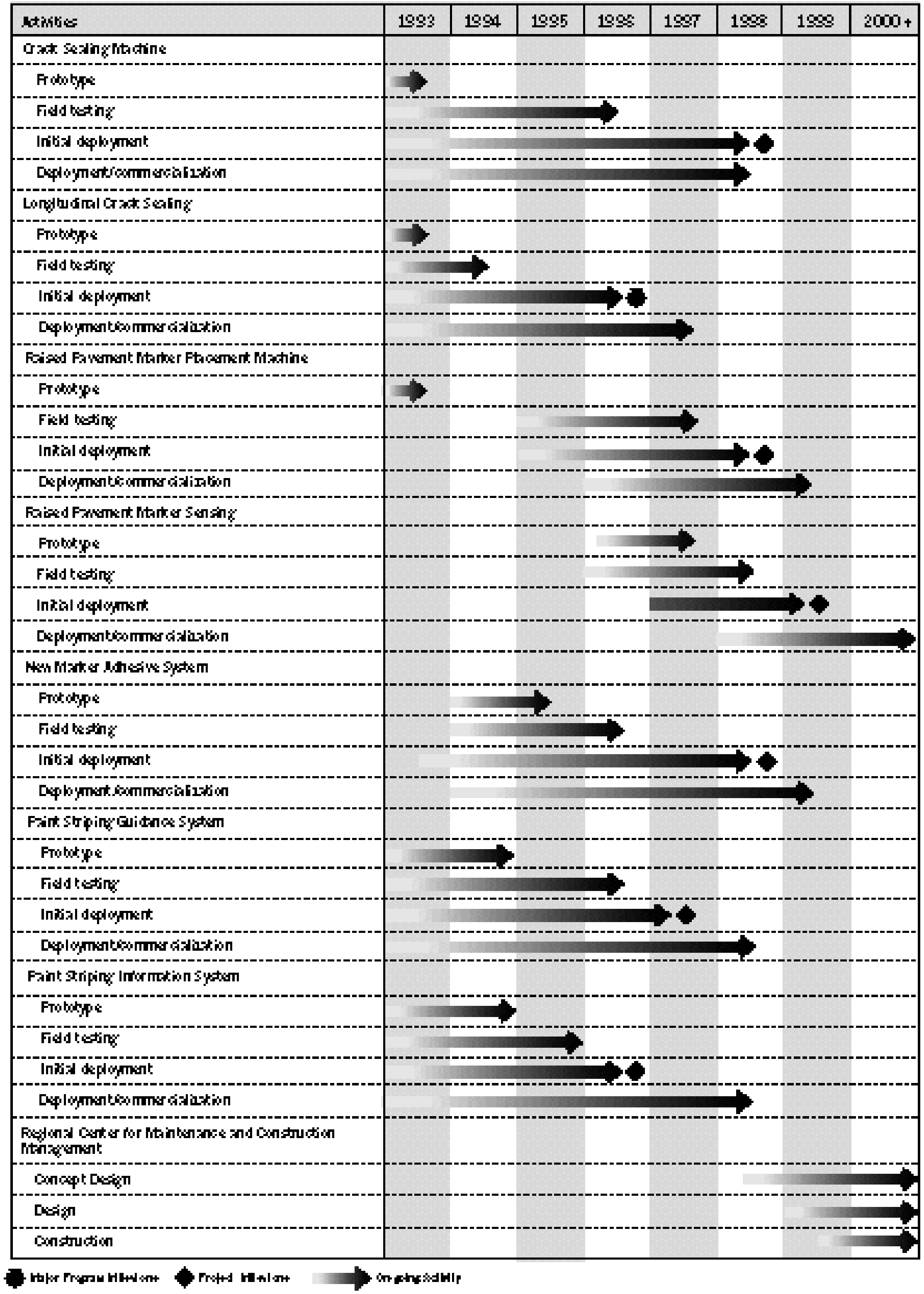
- **ITS/AHS Related Infrastructure Maintenance and Construction**

As more technologically advanced transportation systems are implemented, construction and maintenance operations will become more complex. ITS construction and maintenance will require accurate equipment positioning, frequent testing, and rapid repair of control and communication instrumentation. Such achievements will be critical to automated transportation systems. Recent advances in design for automated assembly, manufacturability, and life cycle, have sanctioned the evaluation and development of new concepts for automated construction and maintenance of a demanding ITS infrastructure.

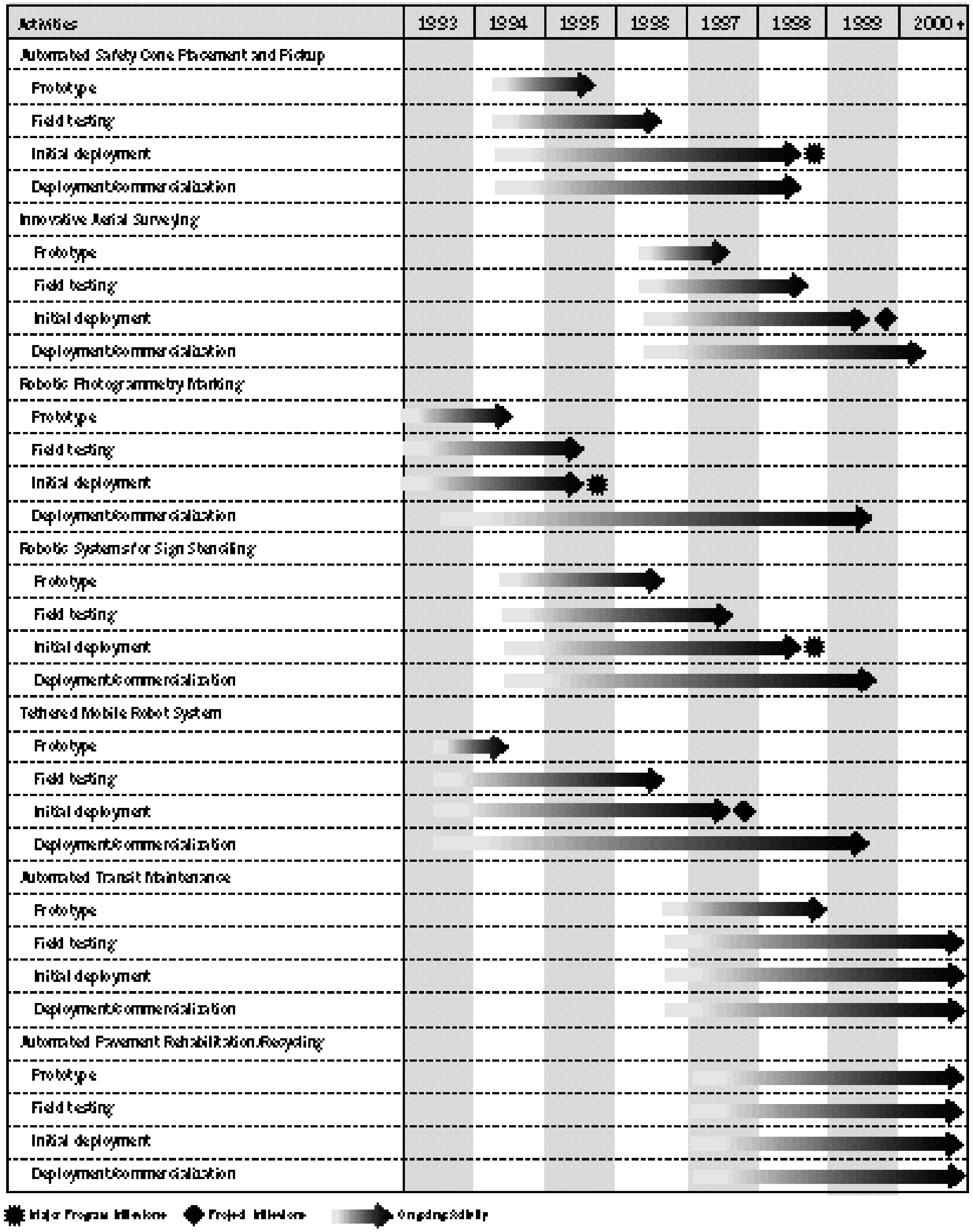
Infrastructure Construction & Maintenance

Activity Charts

Roadway Maintenance & Construction



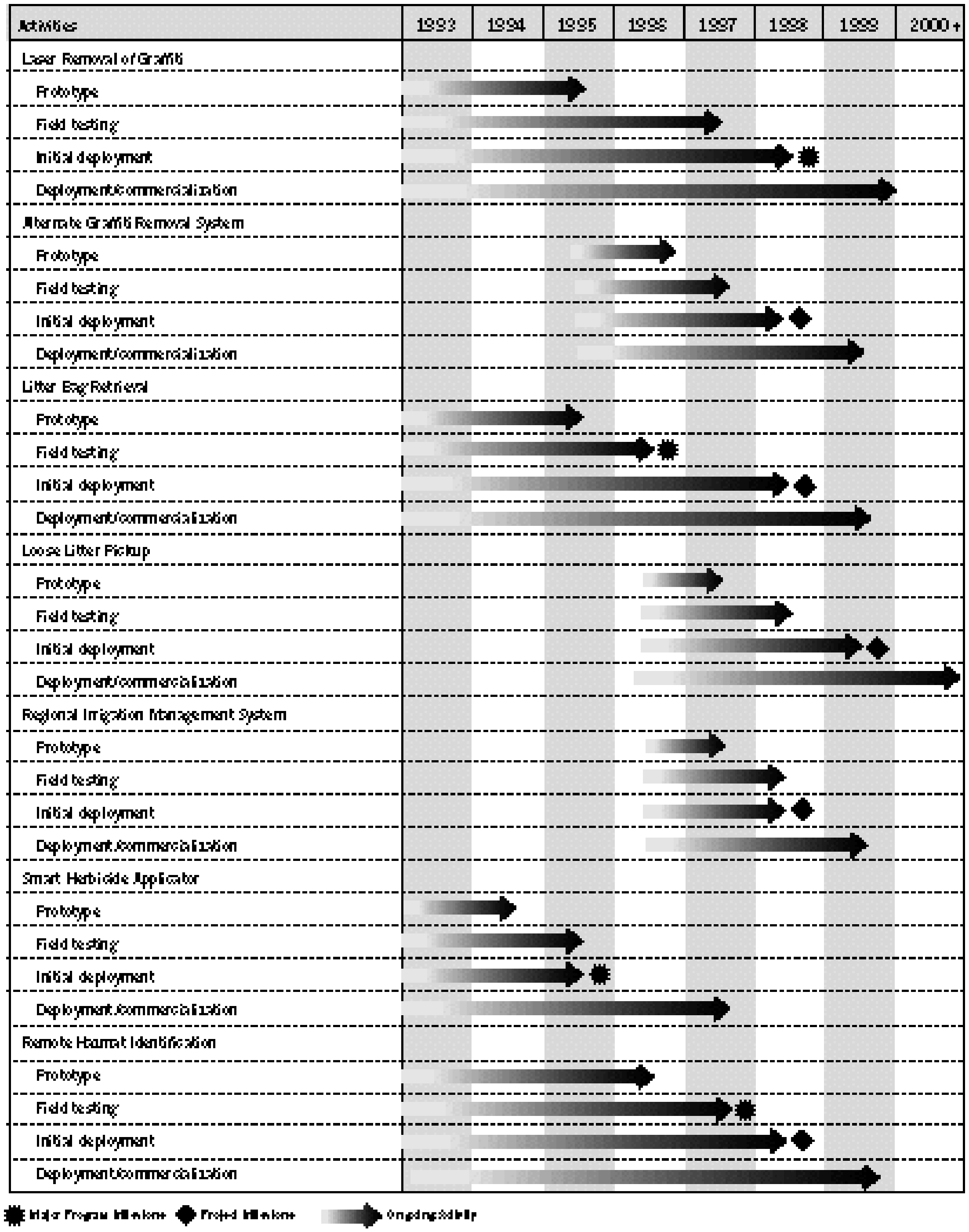
Roadway Maintenance & Construction cont'd



Infrastructure Construction & Maintenance

Activity Charts

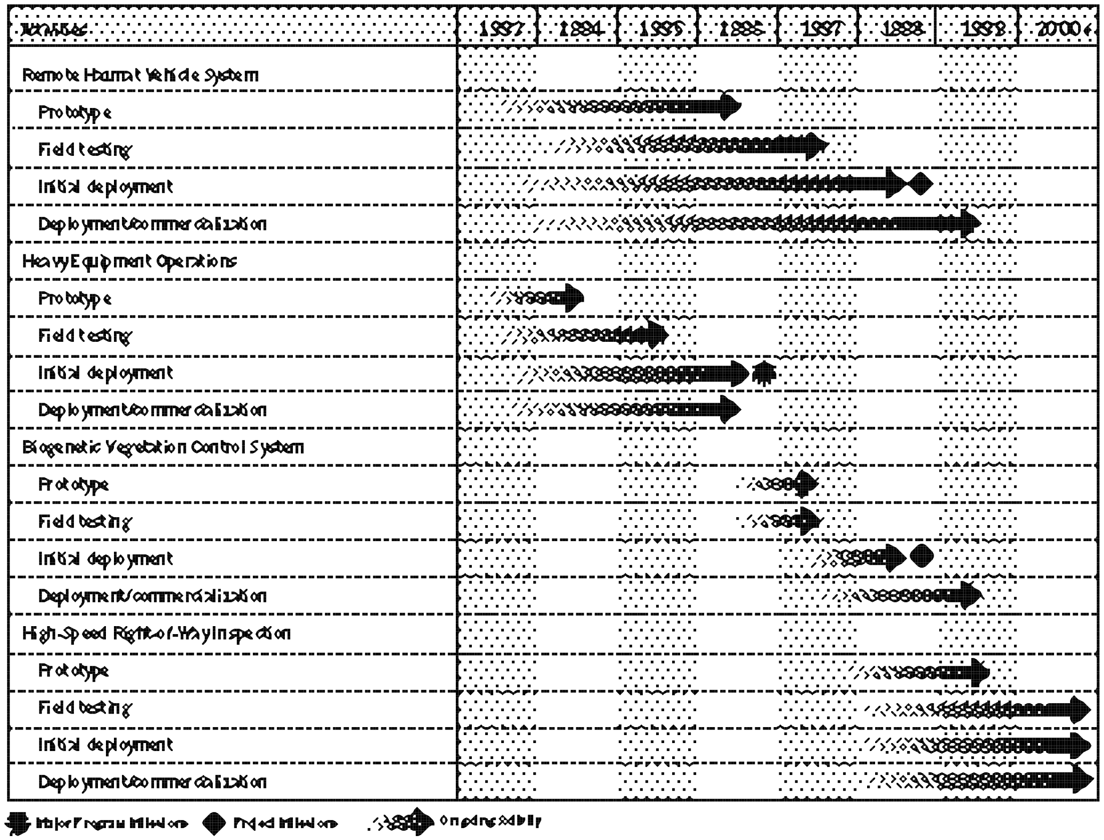
Roadside Maintenance & Construction



Infrastructure Construction & Maintenance

Activity Charts

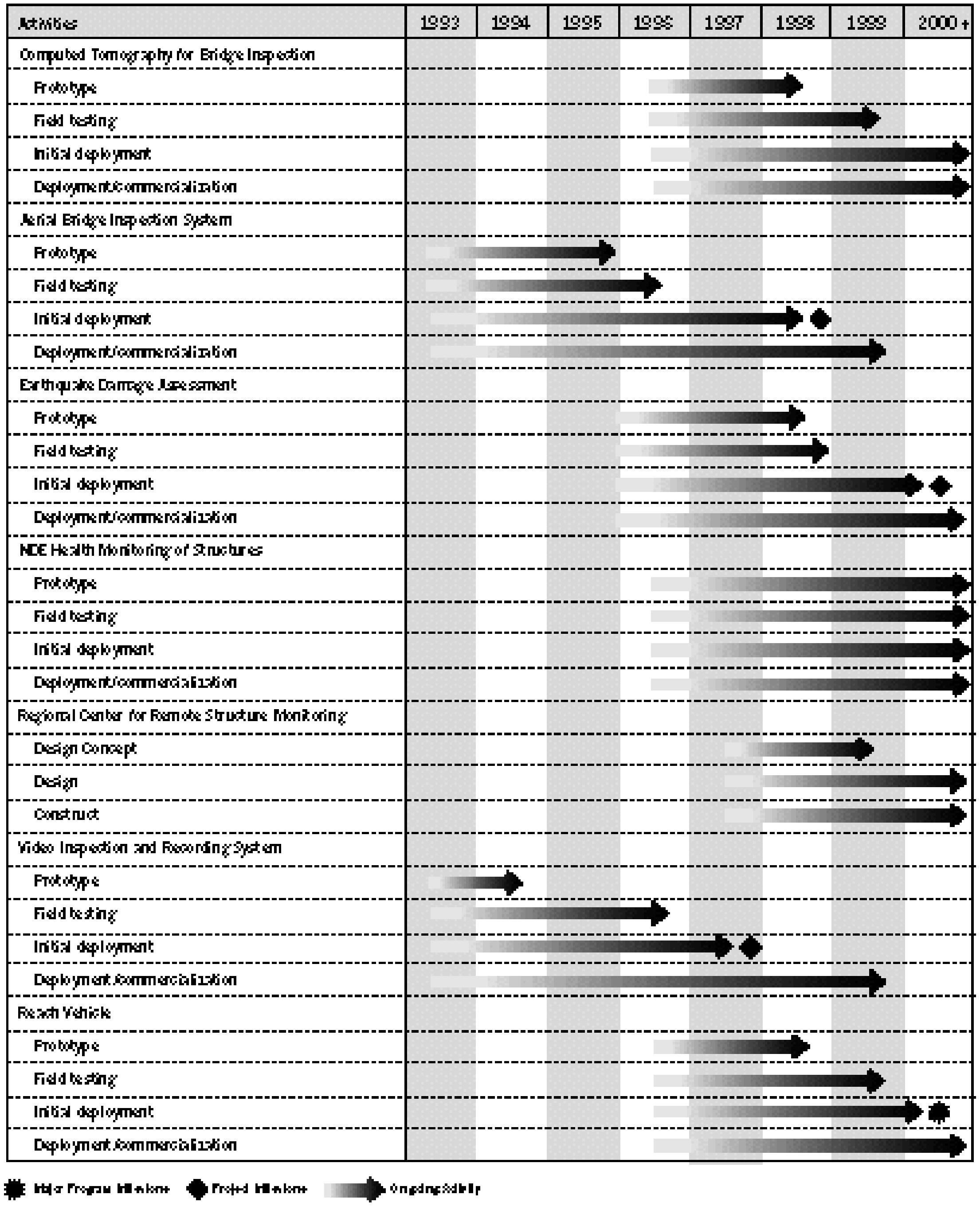
Roadside Maintenance & Construction contd



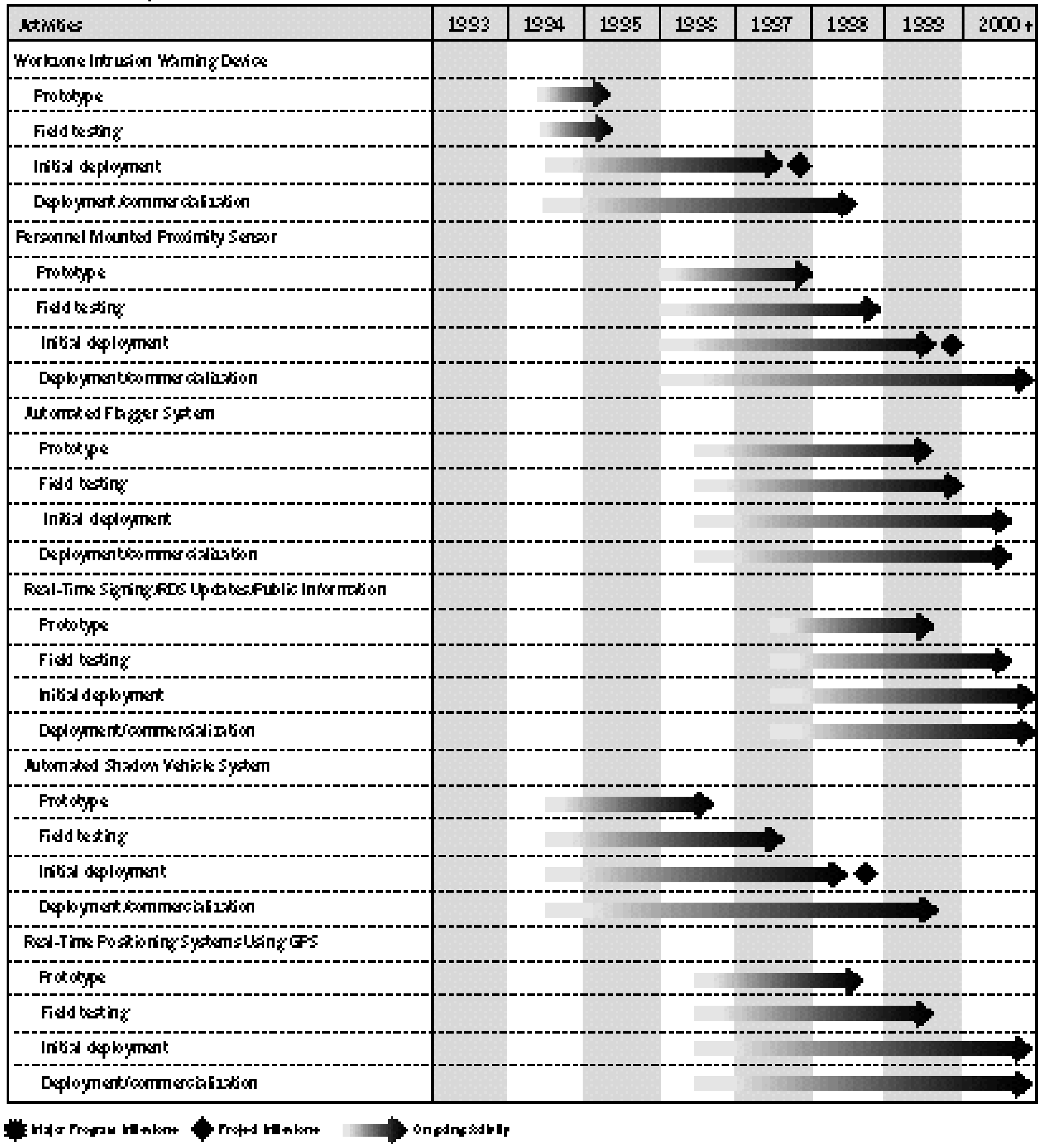
Infrastructure Construction & Maintenance

Activity Charts

Structure Maintenance & Construction



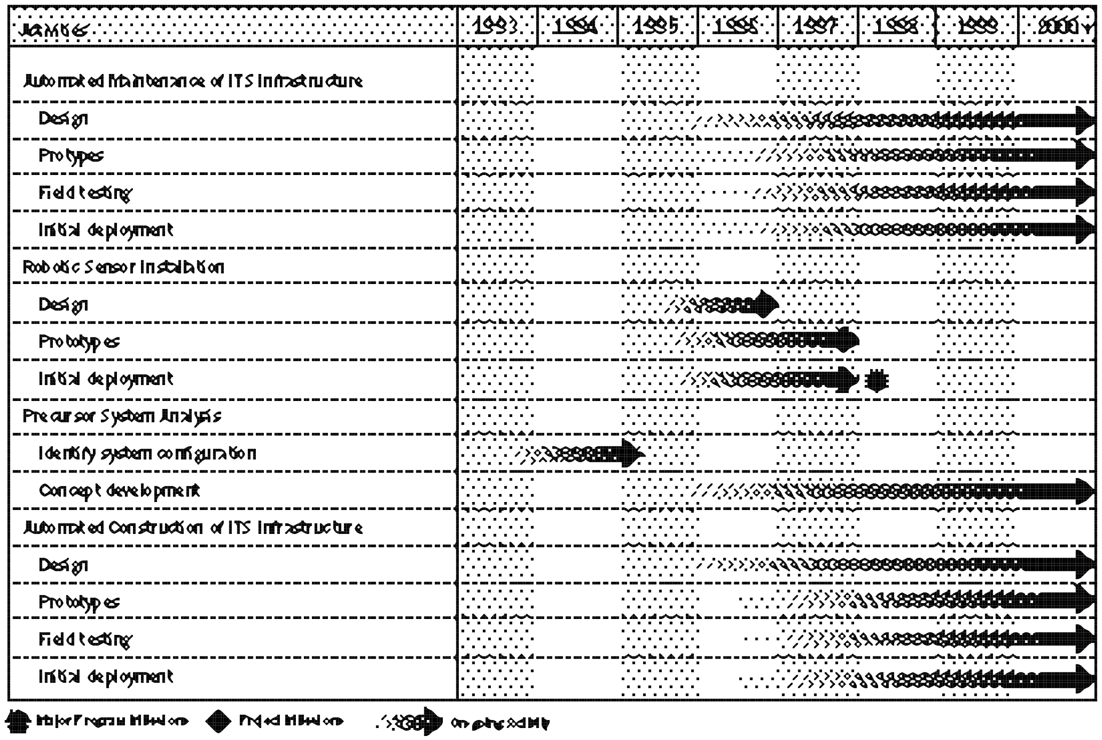
Workzone Safety Enhancements



Infrastructure Construction & Maintenance

Activity Charts

ITS/AHS Infrastructure Maintenance and Construction



The following AHMCT projects show the most immediate potential for commercialization or extensive field prototype operation:

Crack Sealing Machine

The Automated Crack Sealing Machine (ACSM) is a self-contained prototype vehicle for automatic identification, preparation, and sealing of roadway cracks—a conventionally dangerous, slow, and labor-intensive operation. This vehicle will increase the efficiency of crack sealing and enhance the safety of maintenance workers and the traveling public, as well as reduce the time necessary for lane closures.

The vehicle is equipped with a vision system, a robot positioning system, and computer and mechanical support systems. During automated operation, the vision sensing system detects the position of cracks, including their orientation, while the relative position of the vehicle is continuously monitored by a dead-reckoning system. The crack data is buffered and processed by modules which determine the order of cracks to be sealed as they become accessible in the sealing workspace and positions the robotic arm with a custom sealant head along the calculated crack positions. The sealant head, custom designed to fill and seal any size crack according to standard specifications, is so innovative that interest from maintenance and industry personnel has encouraged accelerated efforts to commercialize it as an independent material delivery module.

A longitudinal crack sealing vehicle has been developed to seal only the continuous pavement joints along lanes. The quick-moving vehicle uses the same custom sealant head as the general crack sealing machine, and has been tested in Caltrans District 2 (Redding), District 3 (Marysville) and District 11 (San Diego).

Robotic System for Sign Stenciling

The traditional method of stenciling is a very slow, labor-intensive operation that requires manual placement of a stencil and paint, exposing maintenance workers and the traveling public to hazards. The goal of the new stenciling system is to improve the safety, reliability and efficiency of the roadway sign stenciling operation through the application of automation and robotic technologies. The first prototype resulting from this project focuses on the stenciling of survey premarks for photogrammetry. Using the automated stenciling system, a single operator can accurately complete the painting operation from within the cab of the maintenance vehicle in a fraction of the half-day-per-mile required by the traditional four-person survey crew. By eliminating or reducing the exposure of workers to traffic, the safety, speed, and efficiency of the stenciling operation is significantly improved.

Crack sealing machine prototype testing, District 3 (Marysville)

Infrastructure Construction & Maintenance

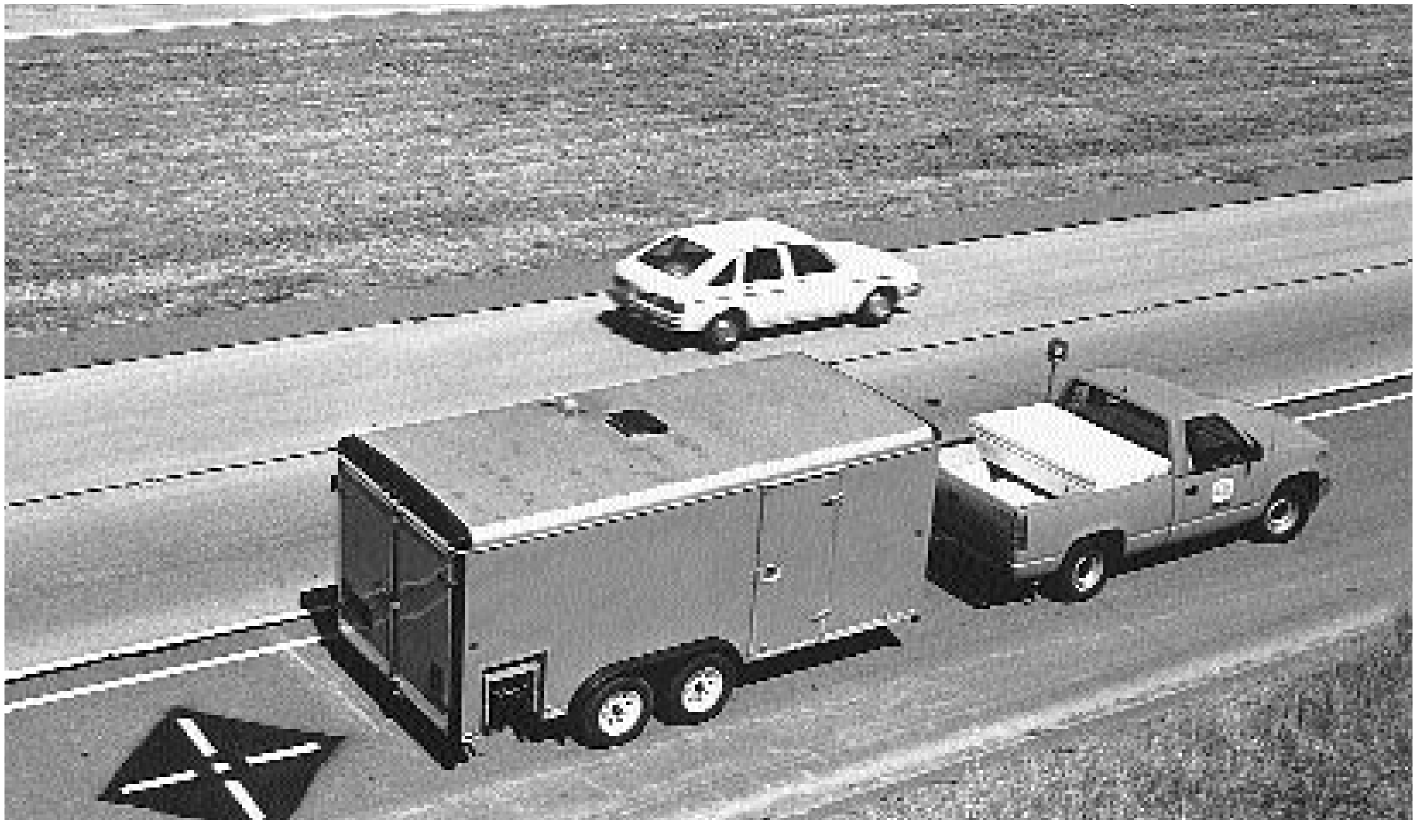
Project Highlights

TAMER equipment in operation. Both of the methods shown, the backpack unit and stationary console, are available for remote operation.

Remote-Control Heavy Equipment

Heavy equipment such as crawler tractors, dozers, and loaders, are often used in hazardous situations such as clearing avalanches, landslides, and snow, as well as cleaning up hazardous materials. The respective equipment operators are by necessity exposed to this high-risk, unstable environment. Remote controlled capability permits the operator to control the equipment from a safe distance when the conventional operation is deemed dangerous. The remote distance for reliable operation is 488 meters (1600 ft).

Teleoperated and Automated Equipment Robotics (TAMER) technology has most recently been applied to a Caltrans front-end loader. It is anticipated that such a remote-control system could also be adapted to other existing maintenance and construction equipment.



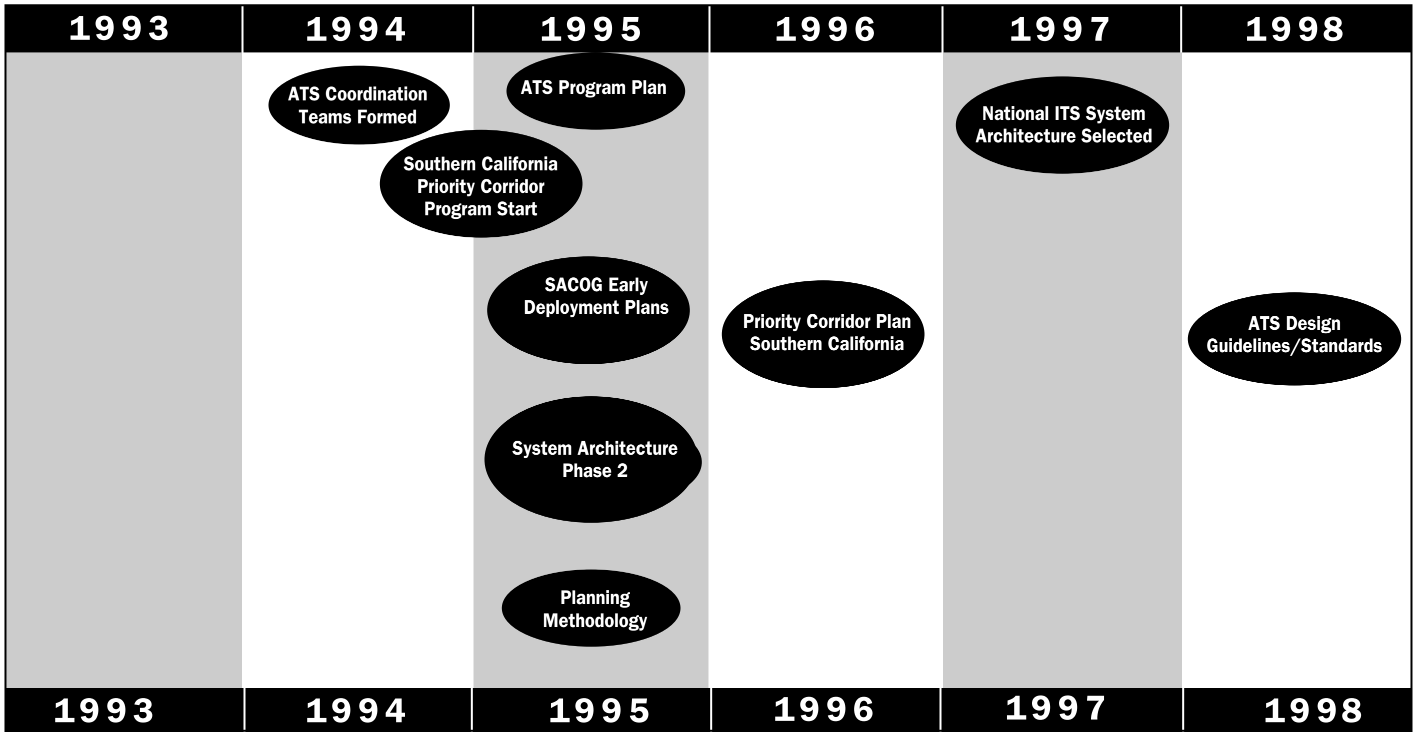
Robotic System for Sign Stenciling in operation.

SYSTEMS DEVELOPMENT, INTEGRATION AND IMPLEMENTATION

Systems Development, Integration and Implementation includes Caltrans involvement in integrated systems design and operation framework; planning, programming and environmental aspects, as well as legal and institutional issues associated with the deployment of advanced transportation technologies in California.

The milestones, scope of services, activities and specific project highlights for Systems Development, Integration and Implementation are discussed on the following pages.

System Development, Integration and Implementation



Systems Development, Integration and Implementation

System Architecture-Scope

ITS Architecture Definition

An ITS architecture is a framework that defines the system elements, determines their functions, and describes how the elements interact with each other. It describes the system operation by what data is collected, what information is distributed, and the means by which that is accomplished. The framework is presented via charts and diagrams, along with narratives. The architecture framework is *not* a system hardware or software design and it is not a policy decision or directive.

System architecture presents the total perspective to aid in the analysis and design of the individual ITS parts while taking into consideration the needs and constraints of the transportation system as a whole. Within this context, the objectives for the ATS Program are to:

- Define an integrated system design and operational framework. The best approach to designing such a framework is to develop an overall system architecture that will determine not only the functions of individual components, but more importantly, their connectivities (design) and interrelationships (operation);
- Analyze the system-level aspects that could create problems or have impacts on the system as a whole, and not necessarily on its individual parts. Such problems would apply to system modeling of interconnection/communications, design, human factors, reliability, optimization, openness, and full automation;
- Synthesize and integrate the various components and subsystems as they are being developed, produced, and deployed to insure their connection, the correction of deficiencies, and elimination of duplication and unwanted redundancies; and,
- Synchronize research and development, as well as deployment work across all programs to ensure efficient use of time and resources, as well as satisfactory progress and timely completion of tasks.

The degree to which these objectives are accomplished determines how timely and complete the intermodal advanced transportation system can be, as well as how efficiently and harmoniously it will operate.

Significance of the ITS Architecture

The significance of the ITS architecture stems from its ability to allow nationwide deployment of compatible transportation systems and synergistic transportation services. The architecture's significance is manifested by its stated objectives which are:

- Promote national compatibility via determining and implementing national standards and protocols for vehicle-to-vehicle and vehicle-to-infrastructure communications;
- Facilitate ITS user service integration via a framework for integrating data collection, data transmission, information processing, information dissemination, traffic control, and intermodal transportation system functions;
- Accommodate new and evolving user services via a structural framework of basic building blocks for incorporating new systems and functions; and,
- Provide regional, institutional, and consumer decision-making flexibility in implementing ITS systems without weakening the above three objective benefits.

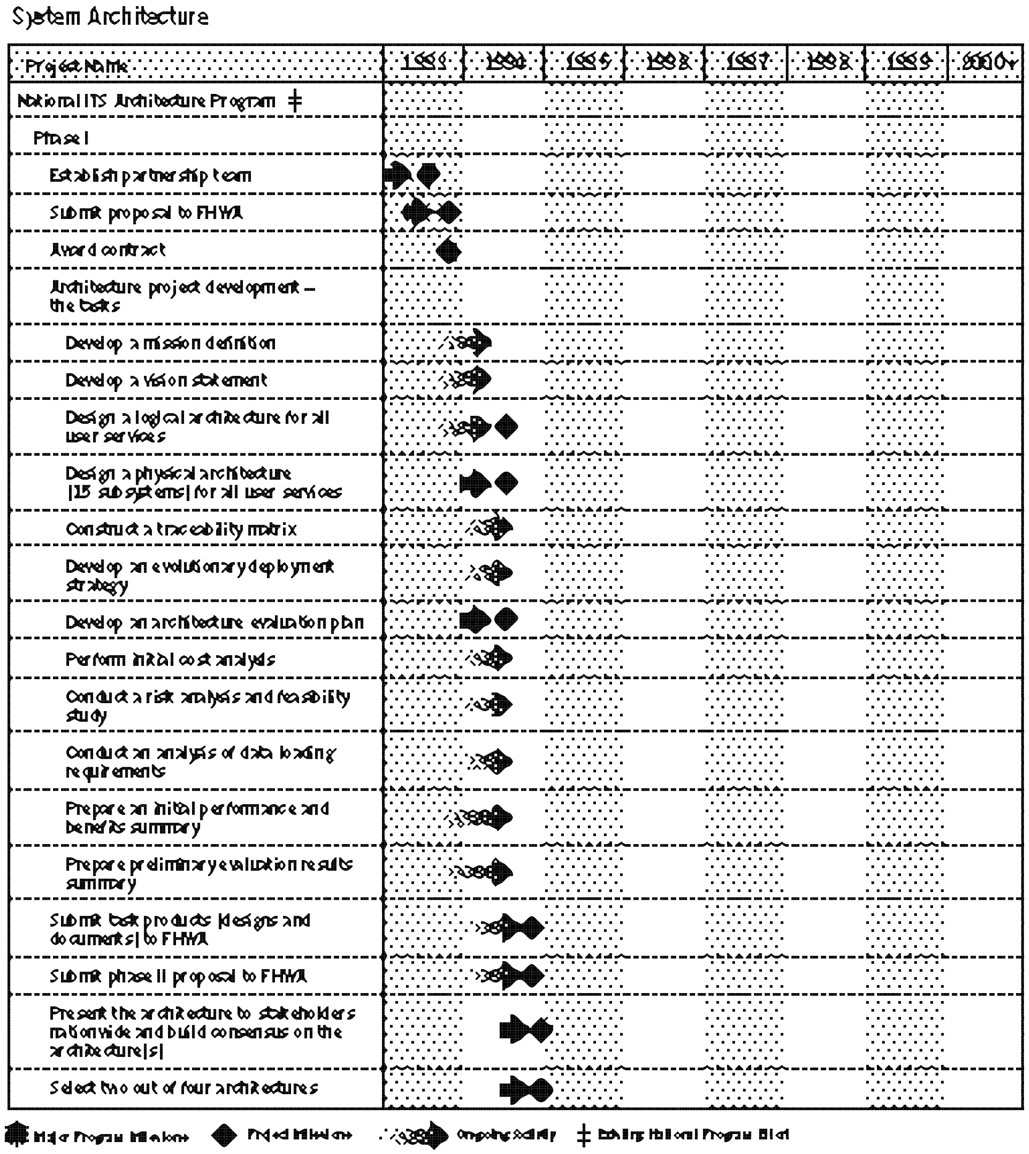
Caltrans' Involvement in the National System Architecture Program

Caltrans is an active participant in the Architecture development process to:

- Insure that California traffic congestion problems and transportation system needs are well addressed;
- Influence the design of the national architecture so it leverages and maximizes the utilization of California's existing transportation infrastructure, as well as California's future plans and investments in the transportation systems;
- Insure that future transportation systems in California are designed/deployed to fit well within the emerging national ITS architectural framework; and
- Share Caltrans' experiences with, and provide expertise to, the FHWA, as well as to the rest of the states' DOTs.

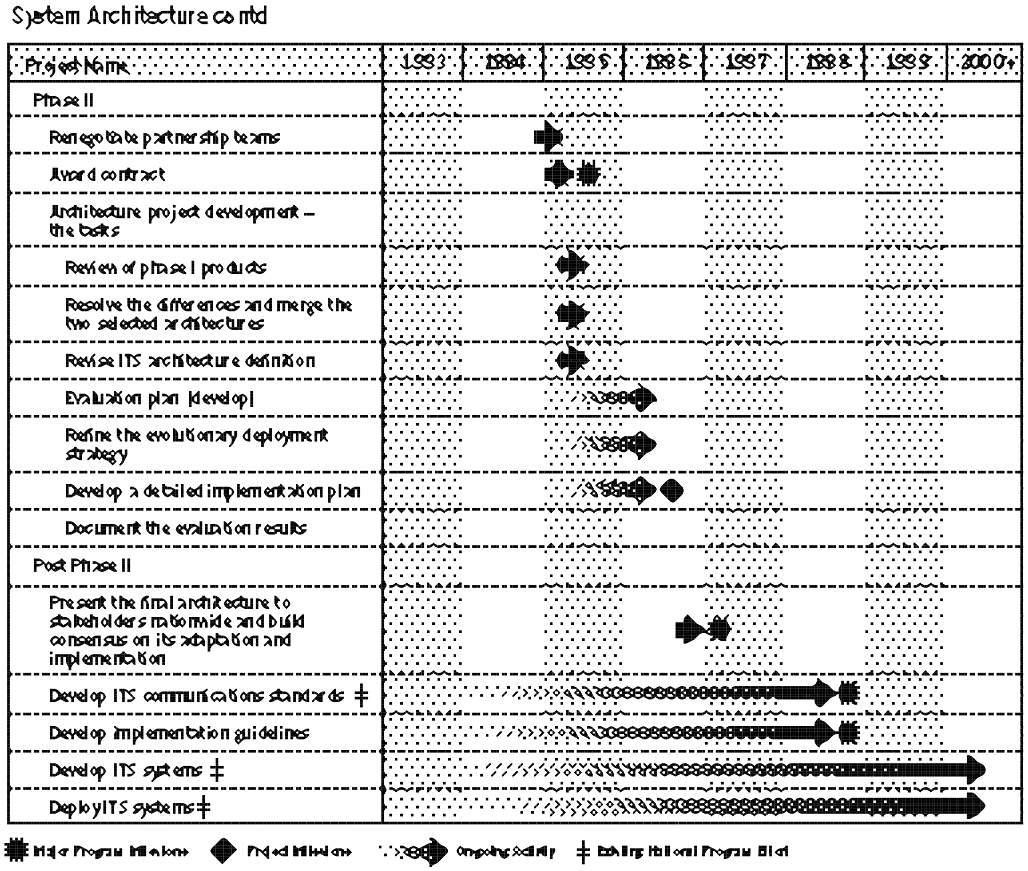
Systems Development, Integration and Implementation

System Architecture-Activity Charts



Systems Development, Integration and Implementation

System Architecture-Activity Charts



Systems Development, Integration and Implementation

Institutional and Legal Issues - Scope

For Caltrans, the scope of institutional and legal issues covers planning, programming and environmental needs, as well as legal and institutional barriers. Caltrans, in cooperation with all levels of government, the private sector, academia, and various interest groups, is working on several fronts to help assure timely and responsible deployment of advanced transportation systems in California. Examples include:

- Caltrans is working with its partners to establish regional teams throughout the state to coordinate ATS programs and activities and help facilitate ATS deployment;
- Caltrans, in cooperation with local and regional agencies, is preparing the Southern California Priority Corridor Plan as provided for in ISTEA to showcase ITS technologies in Southern California (see Project Highlights); and,
- Caltrans, in cooperation with ITS America and the Federal Highway Administration, co-sponsored a policy conference on air quality in June 1994. This was the third conference in a series addressing the relationship of ITS to air quality.

Caltrans is considering state policy and legislative initiatives that will support ATS and related economic endeavors such as:

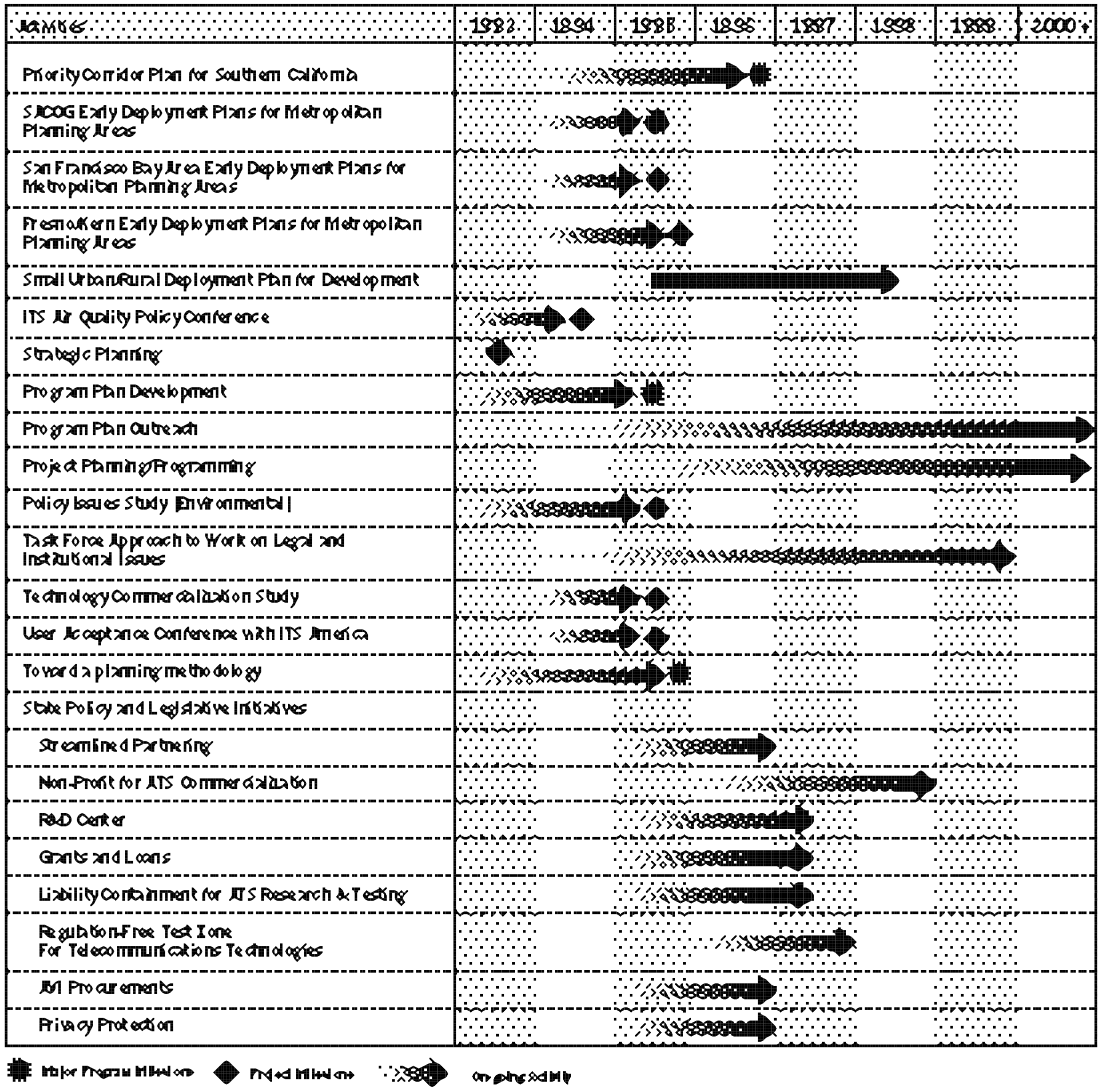
- Streamlined partnering arrangements for the program
- Non-profit corporation for ATS commercialization
- Grants and loans for ATS innovations by small businesses
- Liability containment for ATS research and testing in California
- Regulation-free test zone for telecommunication technologies
- AVI procurements for public fleet vehicles
- Privacy protection in ATS deployment

The five-year activity charts for these and other activities provide the institutional base for ultimate deployment of advanced transportation systems, products, policies and services.

Systems Development, Integration and Implementation

Institutional and Legal Issues - Activity Charts

Institutional Issues



Systems Development, Integration and Implementation

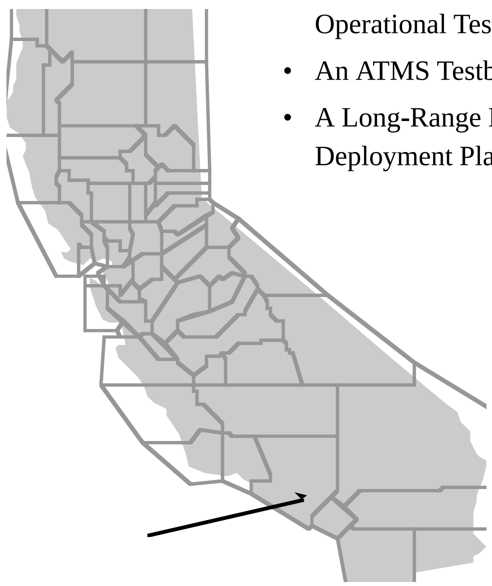
Systems Architecture and Institutional Issues - Project Highlights

A Showcase of ITS Technologies and Stakeholder Cooperation

The Southern California Priority Corridor, one of four corridors identified in the nation, is to be a showcase for the deployment of intelligent transportation systems (ITS). Southern California is a major destination for international travel and goods movement. Travelers and goods flow to and through the corridor from Asia, Mexico, Central America, South America and Europe to destinations in Southern California and the rest of the nation. It is critical, therefore, that the transportation system supports the smooth flow of people and goods through the most populated area in the state.

The four major efforts occurring in the corridor are:

- An Intermodal Transportation Management and Information System (ITMIS) Showcase Project;
- Five Smaller-scale Field Operational Tests;
- An ATMS Testbed; and,
- A Long-Range ITS Strategic Deployment Plan.



An important component of the showcase of ITS is the institutional cooperation that is necessary to accomplish these objectives. The Southern California Priority Corridor partners have begun to lay a solid foundation by establishing cooperative agreements, regional teams, and a steering committee to assure the effective execution of the four initiatives. Local participation and leadership will be emphasized in the management of this effort.

ITMIS Showcase Project

The showcase is a major effort to integrate intelligent transportation system technologies into a model intermodal transportation management system. The project will design, implement, operate and evaluate ITS user services which provide linking and optimization of multimodal transportation systems within the region. The showcase project will demonstrate an areawide interactive/integrated transportation management and information system based on real-time, computer-assisted transportation management and communications. User service will include:

- Real-time information to travelers and operators;
- Decision/management support to transportation management centers, traffic engineering/public safety departments and vehicle fleet operators (public and commercial); and,
- Information/communications network, linking transportation systems and modes which are presently uncoupled, including marine and air.

Field Operational Tests

Five Field Operations Tests have been funded by FHWA in the corridor.

- In the city of Irvine, an integrated ramp metering/adaptive signal control project will evaluate the operational effects of balancing traffic flow between I-5/I-405 and the parallel arterial streets. The project will also demonstrate the effectiveness of collaborative action on the part of transportation management agencies to optimize their strategies to improve traffic flow.
- The city of Anaheim is testing Split, Cycle, Offset Optimization Technique (SCOOT) as an adaptive signal timing control package. SCOOT automates the data collection process and then automatically optimizes traffic signal timing based on real-time traffic conditions. Video Traffic Detection System cameras will be installed and evaluated in conjunction with the SCOOT system.
- At locations throughout Orange County, a Mobile Surveillance Field Operations Test will evaluate the use of a portable detection and surveillance system for highway construction, special events, and incident locations. Specially-equipped trailers will be placed at temporary traffic congestion locations. Trailer-mounted video image detectors will use spread spectrum radio for transmission of real-time information to state and local control centers.
- State, regional and local agencies in San Diego will take advantage of the extensive call box system to increase their functionality by adding an interface to traffic management devices. These “smart” call boxes will collect traffic census data; obtain traffic counts, flows and speeds for accident detection; detect and report hazardous weather conditions; control changeable message signs, and operate roadside closed-circuit television cameras.
- The city of Los Angeles is conducting a spread spectrum radio traffic interconnect project to evaluate wireless traffic signal communications. The radios will be tested in a network of signals to determine their ability to reliably re-route communications links, their ability to work in a variety of geographies, their ability to provide for large-scale once-per-second communications, and to determine the cost-effectiveness of using this technology.

Systems Development, Integration and Implementation

Systems Architecture and Institutional Issues - Project Highlights

Testbed

The Advanced Transportation Management Systems (ATMS) Testbed is a cooperative program sponsored by Caltrans, PATH and local agencies in Orange County to enable ongoing research, testing and evaluation activities for development and operation of integrated multijurisdictional and multimodal transportation management systems. The testbed utilizes existing real-time, computer-assisted traffic and transportation management systems and PATH labs at the University of California, Irvine and California Polytechnic State University, San Luis Obispo.

The ATMS testbed is intended to:

- Provide an instrumented, multijurisdictional, multiagency transportation operations environment linked to university laboratories for real-time technologies and applications. It will enable off-line testing of products and further development of research prototypes prior to installation in the field;
- Provide a meeting ground for practitioners and researchers to try new approaches to transportation system management;
- Enable private industry to demonstrate and evaluate their prototyped technologies under real-world traffic conditions; and,
- Make available a continual testing ground for California and national ITS efforts.

Strategic Deployment Plan

Early deployment planning for intelligent transportation systems in the Priority Corridor will occur over an 18-month period. A Strategic Deployment Plan, estimated to be completed in the summer of 1997, will address the 29 user services defined by ITS America as they would apply to the needs of Southern California. The plan will identify "early starts," as well as a 20-year plan/schedule and funding estimates for deployment of ITS elements. Public participation is an important element of the plan. To define the needs of the users of all transportation systems and modes, input will be solicited from commercial freight operators, transit operators and travelers.

Start-up activities in the corridor have already provided an exceptional opportunity to develop partnerships with stakeholders. These include MPOs, state agencies, air quality management districts, cities, counties, and transit districts. The opportunity to participate will continue to expand to include various modal operators, private industry, and others.

ATS Program Resource Needs

Stability in state funding that parallels ISTEA is essential if California is to realize the vision set before it. Currently $12.9 million in state funds is annually budgeted to leverage, in conformance with AB3096, $20 million in federal funds and $10 million in cost sharing from Caltrans' partners.

This baseline budget provides Caltrans with the minimum state funding necessary to ensure viable California economic partnerships to continue current major program initiatives in the areas of the Automated Highway Systems (AHS) Prototype; Priority Corridor Showcase; Smart Traveler Deployments (urban); Deployment Planning (urban and rural); Transportation Management Systems Testing; and, Automated Highway Construction and Maintenance.

However, a more aggressive ATS market approach could have far reaching economic benefits for California in key market areas, such as: nearer-term vehicle safety products; multimodal traffic management; advanced fleet management; and, premium traveler services packaged for new multimedia and telecommunications markets.

This market approach requires aggressive institutional issues resolution to assure integrated public/private efforts, cooperative research, development, and testing, supporting technology deployments in the public infrastructure, and standards development to accelerate commercialization. Accordingly, adoption of state policy and legislative initiatives may be required.

The resource estimates for aggressive research, development and testing of technologies on an annual basis are:

- State - $30 million;
- Federal - $20 million; and,
- Partners - $30 million.

Public infrastructure improvements/deployments are estimated at $300 to $500 million from all sources.

A strong commitment to the ATS Program will further mobility and economic opportunities for California. The program's vision will be realized primarily through strategic deployment of technologies to the public transportation infrastructure. Private sector investment and commercialization will be necessary. This holds great potential for establishing new California businesses in international markets and the creation of jobs for Californians into the 21st century.